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NATIONAL PLANT BIOSECURITY RESEARCH, DEVELOPMENT & EXTENSION STRATEGY

2013 – 2016

PRIMARY INDUSTRIES STANDING COMMITTEE
NATIONAL PRIMARY INDUSTRIES RD&E FRAMEWORK

Executive Summary

The National Plant Biosecurity RD&E Strategy (the Strategy) is a component of the National Primary Industries RD&E Framework, an initiative of the Standing Committee on Primary Industries (SCoPI). The aim of this Framework is to ensure Australia's RD&E capacities are aligned nationally with future industry and community needs, to initiate collaboration that strengthens Australia's position internationally and to ensure that RD&E delivery is both efficient and effective.

The Strategy establishes the future direction for improving biosecurity RD&E for Australia's plant industries. That is, RD&E to ***manage the risks to the economy, the environment and the community, of pests entering, emerging, establishing or spreading.***

For the purpose of this Strategy the term ***pests*** will include all invertebrate pests (insects, mites, snails and nematodes), pathogenic microbes (bacteria and fungi), viruses, viroids and pest plants (weeds) that are injurious to, plants, plant products and bees. Both terrestrial and freshwater aquatic weeds impacting on plant productivity, plant health, trade or market access are in scope.

The Strategy vision is:

Australia has world leading science-based systems and capability for safeguarding our plant sector from biosecurity threats.

The Strategy aims to achieve this vision by facilitating a RD&E model that will result in the biosecurity sector:

- developing, implementing and evaluating Australia's long-term strategic RD&E needs and priorities
- promoting and facilitating collaboration
- coordinating RD&E effort between sector specific and this cross sector strategy to ensure maximum benefit to all stakeholders and to minimise duplication of effort
- monitoring Australia's RD&E capability
- evaluating, reviewing and reporting on the impact of the Strategy.

Policy framework

The Australian plant biosecurity system is complex, involving coordinated action by industry at all stages of the plant and plant products production chain, and by governments, researchers, communities and citizens.

High level policy that has guided the development of this Strategy includes:

- The Intergovernmental Agreement on Biosecurity (IGAB) and its specific RD&E schedule (Schedule 8) for science-based improvement of the biosecurity system.
- The National Plant Biosecurity Strategy (NPBS) especially Strategy 8 which relates directly to Developing a National Framework for Plant Biosecurity Research.
- The National Primary Industries RD&E Framework which requires a strong culture of collaboration and coordination between the bodies and strengthens national research capability to better address sector and cross sector issues.
- The National Plant Biosecurity R&D Priorities Framework that identifies a set of four broad national biosecurity R&D priorities that identify important under-developed and under-resourced areas of plant biosecurity research.

- The National Biosecurity Committee (NBC) has been tasked with implementing the IGAB schedules and this Strategy incorporates the NBC Working Group considerations and the Primary Industries Standing Committee (PISC) RD&E considerations making it a single reference document for focusing all government activity in RD&E for plant biosecurity.
- Industries also need to incorporate biosecurity measures across the plant production chain, for example managing on-farm pest risks, and this document provides a mechanism for industry and government policy requirements to be co-ordinated via a single means.

Several issues and challenges were identified through a national audit that gathered information on national biosecurity R&D capability across multiple biosecurity sectors (plant, animal, invasive species). The audit was to inform the development of the National Biosecurity RD&E Framework, the National Plant Biosecurity RD&E Strategy, the National Animal Biosecurity RD&E Strategy and Schedule 8 of the IGAB.

The audit included biosecurity R&D and explicitly excluded the E (extension) and service delivery activities. Extension was excluded in the audit as the audit only covered government agencies and the bulk of E is delivered by the private sector. Inclusion of E is essential to ensue outputs of R&D are delivered to the target audience.

Despite a number of limitations, the audit findings are broadly consistent with the identified National Biosecurity R&D Priorities and indicate research funding gaps in sociological research to support risk management and improving understanding of the triple bottom line impacts of pests and the management activities to control them. A future challenge is to balance RD&E investment among the identified priority areas. A further challenge is to maintain infrastructure and the human capital that underpins the scientific capacity and capability, and to enable efficient access to those resources as part of an effective national plant biosecurity RD&E system. Priorities for extension and its integration with R&D need to be developed, for example planning and implementation of biosecurity risk management on farm.

The general consensus is that Australia needs a flexible, adaptable national system for plant biosecurity RD&E, with good information flow and recognition of priority areas of expertise and capability.

Strategic Responses

Consideration of the issues and challenges has provided the opportunity for stakeholders to outline 6 Strategic Responses:

1. Monitor key activities in plant biosecurity R&D including reviewing the ongoing capability review process so that the integrity of the biosecurity system can be maintained and ensure skills across all disciplines are maintained in support of the national effort.
2. Identify and prioritise RD&E areas in plant biosecurity including (but not limited to);
    - I. Developing National RD&E Programs with consideration to developing a mechanism to ensure that fundamental research is a significant component of the national plant biosecurity R&D effort,
    - II. Develop a commissioned research plan, which includes a feedback mechanism, to underpin succession planning for key staff or disciplines,
    - III. Ensure funding providers consider the impact of endemic pest R&D on preparedness for exotic incursions.
3. Conduct an annual national stakeholders workshop to contribute to the determination of priorities for plant biosecurity RD&E.
4. Develop a dynamic mechanism for collating and providing strategic plant biosecurity information, R&D priorities and infrastructure needs to key stakeholders, eg funding bodies and research providers.
5. Support R&D funding directed towards national centres of excellence for plant biosecurity research.
6. Develop systems and strategies for the efficient storage, effective distribution and uptake of R&D knowledge and outcomes.

Implementation

The Strategy will be progressively implemented through a National Plant Biosecurity RD&E Implementation Committee. Emphasis will be on implementing a process that will include:

- enacting the Strategy
- the development of coordinated national RD&E programs and the identification of national centres of excellence
- determining the major-support-link roles for plant biosecurity RD&E stakeholders.

As the implementation of this Strategy progresses, some of these strategic responses may become redundant while new areas are added. In order for the Strategy to be effective it needs to be a living and evolving document.

When the Strategy is fully implemented, the plant biosecurity related industries will be strengthened by a national system in which end users of the RD&E can take a leading role in determining and reviewing the RD&E priorities.

Table of Contents

1. Acknowledgements

This Strategy has been prepared by Plant Health Australia (PHA), with advice from a national Steering Committee, comprising a selection of the major investors and providers of plant biosecurity research, development and extension (RD&E). PHA also provided secretariat services for the Strategy.

PHA acknowledges the guidance, direction and strategic oversight provided by the Steering Committee. In addition, PHA would like to thank and acknowledge the contribution of the RDCs, state and Australian governments, universities and RD&E providers for their input, including data, information and advice, all of which was vital in developing this Strategy.

Support was also provided from the NBC RD&E Working Group who assisted PHA in ensuring this document also meets the needs of the NBC needs in relation to the implementation of the IGAB Schedule on R&D.

Furthermore, PHA wishes to thank Jane Moran for her contribution to the Strategy, the Department of Environment and Primary Industries Victoria (DEPI Vic) and the Plant Biosecurity Cooperative Research Centre (PBCRC) for financial support in the development of this Strategy.

Further information

Further information on the national RD&E framework and underpinning strategies can be found at: **www.npirdef.org/home.**

Steering Committee Members

Steering committee member	Organisation
Rod Turner (Chair), Felicity Andriunas, Nicholas Woods, Stephen Dibley, Ashley Zamek	Plant Health Australia (PHA)
Cameron Allan	Meat and Livestock Australia (MLA)
Vanessa Findlay, Darryl Barbour	Department of Agriculture, Fisheries and Forestry (DAFF)
Gary Fitt, Paul De Barro	Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Kim James	Horticulture Australia Limited (HAL)
Martin Barlass	Department of Environment and Primary Industries Victoria (DEPI Vic)
Michael Robinson – replaced Nick Langley part way through the process	Plant Biosecurity Cooperative Research Centre (PBCRC)
Richard Oliver	Curtin University
Rohan Rainbow	Grains Research and Development Corporation (GRDC)

Steering committee member	Organisation
Shashi Sharma	Murdoch University, Western Australia (on secondment from Western Australia Department of Agriculture and Food (DAFWA))

2. Abbreviations and Acronyms

ABS	Australian Bureau of Statistics
AgriBio	Centre for AgriBioscience
AHA	Animal Health Australia
AWC	Australian Weeds Committee
BSES	Bureau of Sugar Experiment Stations
CEBRA	Centre of Excellence for Biosecurity Risk Analysis
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry (now DoA)
DoA	Commonwealth Department of Agriculture
DPIPWE	Department of Primary Industries, Parks, Water and Environment Tasmania
DAFWA	Department of Agriculture and Food Western Australia
DEPI Vic	Department of Environment and Primary Industries Victoria
EMAI	Elizabeth Macarthur Agricultural Institute
EPP	Emergency Plant Pests
EPPRD	Emergency Plant Pest Response Deed
GRDC	Grains Research and Development Corporation
HAL	Horticulture Australia Limited
IGAB	Intergovernmental Agreement on Biosecurity
IP	Intellectual Property
KPI	Key Performance Indicator
NBC	National Biosecurity Committee
NPBS	National Plant Biosecurity Strategy
NSW DPI	New South Wales Department of Primary Industries
NT DPIF	Northern Territory Department of Primary Industry and Fisheries
PBCRC	Plant Biosecurity Cooperative Research Centre
PHA	Plant Health Australia
PHC	Plant Health Committee
PIMC	Primary Industries Ministerial Council (now replaced by SCoPI)
PIRSA	Department of Primary Industries and Resources of South Australia

PISC	Primary Industries Standing Committee
QA	Quality Assurance
QDAFF	Queensland Department of Agriculture, Fisheries and Forestry
RDC	Research and Development Corporation
RD&E	Research, Development and Extension
RIRDC	Rural Industries and Research and Development Corporation
RRDC	Rural Research and Development Corporation
SARDI	South Australian Research and Development Institute
SCoPI	Standing Council of Primary Industries
SNPHS	Subcommittee on National Plant Health Surveillance
SPHDS	Subcommittee on Plant Health Diagnostic Standards
SRA	Sugar Research Australia
TIA	Tasmanian Institute of Agriculture

3. Introduction

Australia remains free from many pests and diseases that affect agriculture, the natural environment and its people. Australia's $46.7 billion plant industries, along with the environment and infrastructure remain free from, and rely heavily on being protected from numerous economically important pests. In addition, Australia's current biosecurity systems provide agricultural industries protection from a number of potentially economically important pests that are increasing in number and spreading further within Australia. These two factors give Australia a favourable biosecurity status that enables it to produce agricultural goods cheaply, efficiently and sustainably resulting in access to numerous international and domestic markets. This favourable biosecurity status provides significant economic, environmental and community benefits.

The effects of new plant pests establishing, or current pests increasing their distribution in Australia are wide-ranging There is potential to damage the livelihoods of producers and others along the value chain, and newly intoduced pests could also jeopardise trade (domestic and international), damage regional economies, deplete amenity values and affect food security for the broader Australian community.

For the purpose of this Strategy the term ***pests*** will include all invertebrate pests (insects, mites, snails and nematodes), pathogenic microbes (bacteria and fungi), viruses, viroids and pest plants (weeds) that are injurious to, plants, plant products and bees. Both terrestrial and freshwater aquatic weeds impacting on plant productivity, plant health, trade or market access are in scope.

Maintaining and improving Australia's biosecurity status is the responsibility of all Australians. Each member of the community has a role to play in the biosecurity continuum – mitigating and managing threats offshore, at the border and onshore. Governments and plant production industries share responsibility for the biosecurity system, covering funding and decision making. As well as focusing on preventing the establishment and spread of exotic pests, the system encompasses domestic biosecurity arrangements which limit the spread of regionalised pests within Australia. Investing in a strong, multi-layered system to maintain a favourable biosecurity status benefits all Australians.

Biosecurity is defined as ***the management of risks to the economy, the environment, and the community, of pests and diseases entering, emerging, establishing or spreading*** (IGAB 2013)[1].

[1] IGAB definition (**www.coag.gov.au/node/47, 2013**)

4. Background

4.1 National Primary Industries Research, Development and Extension Framework

This Strategy has been developed as part of the National Primary Industries RD&E Framework (the Framework) initiated by PIMC (now SCoPI).

Innovation and RD&E are key drivers to improving productivity and competitiveness in the primary industries sector, and making best use of Australia's natural resources under conditions of change. The Framework will facilitate greater coordination between research agencies to better harmonise their roles in RD&E related to primary industries and assure that they work together effectively to maximise net benefits to Australia.

The Framework requires a strong culture of collaboration and coordination between the bodies, e.g. state and territory governments, RDCs and industry bodies, and strengthens national research capability to better address sector and cross sector issues. It aims to focus the investment of RD&E resources nationally so they are used more effectively, efficiently and collaboratively, thereby reducing capability gaps, fragmentation and unnecessary duplication in primary industries RD&E. The goals of the Framework are:

- To provide shared strategic directions and priorities for RD&E to enhance the productivity and sustainability of Australia's primary industries.
- For public research capability to become more integrated, with larger critical mass and less fragmentation across the nation, whilst recognising the need for specialisation.
- To improve the efficiency and effectiveness of RD&E and consequent returns on investment.
- For RD&E investment to improve the capability of national systems in priority areas and ensure effective and efficient use of resources, including infrastructure.
- To retain and build capability in fields strategically important to governments and industries.
- For research undertaken in one location to be developed regionally and extended nationally.
- The research capability will more comprehensively and holistically cover the present and future strategic needs of stakeholders nationally.
- The national research capability will be an integral component of a wider innovation agenda, supporting development and extension.

The Framework is being implemented through 14 sectoral and seven cross-sectoral strategies. Sectoral strategies include: beef, cotton, dairy, fishing and aquaculture, forest and wood products, grains, horticulture, pork, poultry, sheep meat, sugarcane, wine, wool and new and emerging industries.

Cross-sectoral strategies include: animal biosecurity, plant biosecurity, animal welfare, biofuels and bioenergy, climate change, food and nutrition, water use in agriculture and soils.

For further information on the Framework refer to the Statement of Intent at **www.daff.gov.au/agriculture-food/innovation/national-primary-industries**. For further detail on the sectoral and cross-sectoral strategies see **www.npirdef.org/strategies**.

5. Vision, high level outcomes and critical success factors

5.1 Vision

The vision for the Strategy is:

> ***Australia has world leading science-based systems and capability for safeguarding our plant sector from biosecurity threats.***

The Strategy will support this vision through efficient and effective ***national cooperative arrangements and actions*** for cross-sectoral plant biosecurity RD&E among industry, government, academic and community organisations.

For the Plant Biosecurity area the aim of this cross-sectoral RD&E strategy is to develop a RD&E model that will result in:

- Delivery of high quality RD&E outcomes for plant based industries seeking to maximise the impact of RD&E investment.
- Improved utilisation of available RD&E funds, facilities and capabilities relevant to plant biosecurity, through enhanced collaboration between RD&E providers.
- Development of networks of RD&E providers that can retain, build and share capability, and deliver leading-edge RD&E relevant to industry and community needs.
- Delivery of an organised framework for RD&E in plant biosecurity that provides greater national and regional coordination of investment and service delivery, enhanced cross-commodity coordination, and improved linkages between plant based production sectors.
- Identified and prioritised R&D areas in plant biosecurity taking into account linked/transferable research for established pests.
- Standardised transparent prioritisation processes in place, conducted in a collaborative manner between government and industry and the use of risk and benefit-cost analyses to establish strong business cases for priority research.
- Well-defined roles for all associated parties.

5.2 High level outcomes

The arrangements and actions indentifed in this strategy will be directed to achieving four high level outcomes.

1. A clear set of research impacts that are collectively developed, then delivered through national RD&E programs and centres of excellence, based on the prioritised needs, following the transparent and defendable process.
2. An RD&E community that works collaboratively rather than competitively.
3. A sustainable funding base that delivers across sectors.
4. A strong governance and consultation framework.

The Strategy is envisaged as a ***living document*** that will develop over time through the joint input of the stakeholders and industry participants.

5.3 Critical success factors

1. Shared ownership and engagement by all stakeholders with a common goal for improved plant biosecurity RD&E endorsed by all.
2. Demonstrated leadership through the Implementation Committee members and via the implementation process.
3. Harnessing and leveraging of knowledge, skills and resources within and across all sectors.
4. Reduction in duplication in RD&E effort and a greater collaborative approach across all funders and deliverers.
5. Integration and recognition of other RD&E strategies covered by the PISC process and other national initiatives and reforms e.g. IGAB and NPBS.
6. High quality and high impact RD&E outcomes delivered as a result of the implementation of this Strategy.
7. Clear funding arrangements that are nationally coordinated and agreed.

6. Scope

The scope of this Strategy (Table 1) includes RD&E relating to:

- All plant pests affecting plants, plant products or bees and/or impacting on trade and market access.
- All production plant pests that impact on the environment.

Table 1. Scope of Plant Biosecurity RD&E Strategy

	Plant biosecurity sectors	
Scope	**Plant health**	**Weeds**
In scope	Primary production crops: • Broad acre • Native and improved pastures • Horticulture • Forestry and timber production Nursery production (includes native plants produced by the nursery & garden industry) Bees (bee pests and diseases and invasive bees) Floriculture Native plants (acting as an alternative host/ reservoir for pests, diseases impacting primary production) Pests of fresh water aquatic primary production plants Timber in service (e.g. European house borer, Lyctus, termites) Postharvest horticulture and grains	Terrestrial weeds impacting primary production (e.g. crop and pasture weeds) Environmental weeds which impact on primary production Freshwater aquatic weeds which impact primary production
Out of scope	Native plant pests/diseases not impacting production Fresh water aquatic plant pests/diseases not impacting production	Environmental weeds not impacting production

NOTE: The Plant Biosecurity RD&E Strategy is a cross sector strategy and needs to develop strategic linkages between the biosecurity RD&E Strategies developed in this strategy with the relevant Sector Specific Strategies. It is not the intent of this strategy to duplicate effort in the sector specific strategies but to capitalise and build on that effort in order to minimise entry and spread of these pests. This linkage is especially important for Plant Biosecurity as there are linkages between endemic and exotic pest management.

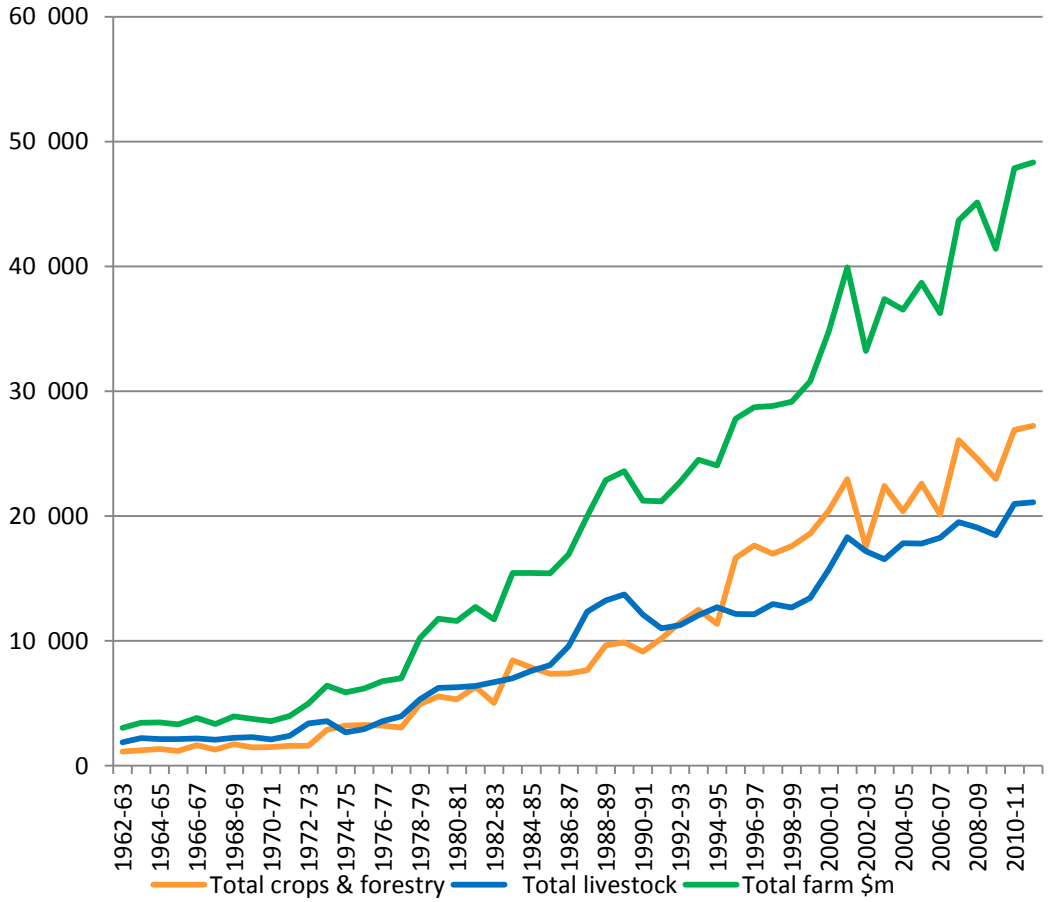
Weeds affecting primary production are covered by the strategy but not environmental weeds. Environmental weeds will be covered through at Environmental Weeds Strategy being developed by the National Biosecurity Committee's RD&E Working Group.

7. Situation analysis

7.1 Biosecurity RD&E sector overview

Australian agriculture, of which plant production industries make up over half, remains an integral part the nation's economy. Over half of Australia's land area is used for agriculture and it has contributed about 2.5 per cent of GDP each year over the past five years. Total agricultural production (excluding forestry) totalled $46.7 billion in the 2011–12 to annual agricultural production (ABS 2012) with plant production industries contributing over $33 billion (see figure 1). Forestry production was valued at $1.6 billion for 2011 – 12.

Figure 1: Growth in Plant and Animal GVP from 1962 to 2011



Whilst fundamentally based on broadacre production, there is increasing diversification into horticultural and forestry activities. There are significant intensive protective cropping industries mainly targeting domestic markets, and a honey bee industry which provides valuable pollination services to crops and horticulture, as well as honey and packaged bee production.

There continues to be strong growth in the plant production sector, with the last decade seeing an increase of over $8 billion. In addition, pasture improvement has underpinned productivity increases in our animal production systems. For the majority of the past 15 years the value of primary plant production has been above that of livestock production in Australia. Crops are produced in every state and territory in Australia, and with the wide variety of soils, geography and climate, this has resulted in some of the most diverse production in the world.

Australia's plant industries also support animal industries through production of food for animals. Sustainable, economic and nutritional feedstocks are vital for Australia's animal industries and risks to this feed supply are of equal significance to the animal industries as to the plant industries that produce it. Without a successful plant production sector Australia's agriculture landscape would be very different. As an illustration of the importance of pasture to animal production Gout and Jones, in their 2006 publication, valued pasture for livestock industries at $12.3 billion annually.

Biosecurity RD&E contributes to market access, trade, commitment to international treaty obligations and consumer confidence. Trade is volatile and there is potential for increasing protectionism in some key overseas markets. There is growing recognition of zoning and compartmentalisation among trading partners. Freedom from trans-boundary pests is a critical success factor for continued access to premium markets, and maintaining consumer confidence and the ability to attract price premiums. Loss of trade for Australia's wheat industries would have estimated losses of $1 billion per annum. Pest freedom also underpins domestic market access and productivity.

Biosecurity RD&E also contributes to the development of Australia's preparedness plans for emergency plant pests (EPPs) and capability for rapid detection and effective responses. For example the rapid diagnosis of a native bunt fungus on grass that was confused with Karnal bunt, by overseas authorities, allowed rapid re-entry of Australian wheat into the international market.

Biosecurity RD&E also contributes to increased productivity and reduced production costs for plant based industries. This is achieved by supporting growers and their advisors with the technologies and practices to prevent establishment and spread, as well as management of pests.

Industry specific biosecurity plans have been developed under the requirements of the Emergency Plant Pest Response Deed (EPPRD) to identify risks against which management strategies can be developed. These plans have been developed using sound technical advice. There has been variable take up of the plans by different industry sectors, which in itself poses a risk across the whole sector that should be addressed.

RD&E under the current system has been divided along industry lines, and cross-sectoral issues, such as biosecurity, have not achieved the scope and collaboration required. Information and knowledge gaps remain and coordination of expertise and resources has been difficult due to the broad range of stakeholders involved. Some of the areas in which broader collaboration is required include the ongoing development of surveillance (on- and off-shore), market access, diagnostics, on farm pest management techniques and practices, refinement of systems approaches and alternative post-harvest treatments. An example of how collaboration between RDCs could be improved through this strategy is the initiative by the PBCRC to invest in bacterial diagnostics development. The development of a broad diagnostic tool for bacterial plant pathogens will be of benefit to all plant based industries and the livestock industries as these tests can be used for diagnosing bacterial diseases of pastures. It is this cross sectoral R&D opportunities that will be investigated through this strategies implementation.

7.2 Overarching challenges to Australia's biosecurity system

Biosecurity management is a complex task and Australia's biosecurity system will need to respond to increasing challenges that are changing its risk profile, including:

- A changing climate altering the range, habitat and spread of pests and increasing the potential for severe weather events to assist spread.
- Globalisation increasing the volume and range of products traded internationally, passenger movements, and the subsequent risk of pests entering and establishing in Australia.
- An increasing connectivity nationally and internationally.
- A decline in human resources at all levels of government, resulting in a decreasing ability to effectively and efficiently manage pest and disease responses.
- Increased demands on the already limited resources of peak industry councils and state farming organisations with reduced ability to contribute to policy development and review.
- Population spread, shifting demographics and changing land uses increasing the interface between urban and rural areas and the natural environment, making pest management more complicated to deal with.
- Disconnect between research and extension delivery services.
- Changing farming practices, including intensification and changing rural land ownership profiles.

Maintaining and improving the success of Australia's plant biosecurity system requires continuous effort. There are a number of substantial challenges, including a diversity of stakeholders, a large coastline of over 60,000 km over which pests could enter, domestic and international regulatory and trade pressures, increasing tourism and trade as well as climate variability. Adding to these challenges is the need to manage human, infrastructure and financial resources within a complex mix of competing demands.

One of the major challenges for the national biosecurity system is protecting the vast range of plant based industries present in Australia. These range from pineapples and sugarcane in the tropical north to cherries and onions in the southern temperate zones, with each commodity having its own unique biosecurity challenges. Based on the past record, over the next 15 years there will be more than 300 responses to exotic plant pests, over 40 trade incidents related to plant pests and at least five occurrences of loss of area freedom impacting on domestic production and market access.

Even with a strong biosecurity system in place, pests pose a significant threat to Australia's plant production industries. They can reduce crop yields, lower the quality of food and fibre commodities, increase production costs, and in some cases, restrict access to international markets for Australia's produce. Plant pests also impact on a large number of stakeholders in addition to plant production industries, including the product supply chain and end-users of plant products. In many cases there are also impacts on the public either directly (inability to grow certain plants in their backyards) or indirectly (impact of Myrtle Rust of street trees and natural ecosystems). For plant biosecurity it is the ability of plant pest to cut across all parts of the continuum that makes this cross sectorial strategy so crucial.

Some specific examples of the impact of plant pests are included below to illustrate the nature of the task before the Implementation Committee:

- ***Oriental fruit fly*** – if established in Australia could add $98m in production costs for farmers across Australia, as well as closing several export markets. Failure to implement an effective surveillance program in north Queensland prior to an outbreak of a related species of fruit fly (papaya) cost

taxpayers $30m more for the eradication response than a similar outbreak in the Northern Territory where there was an effective surveillance program in place. In addition the current Torres Strait fruit fly program protects mainland Australia from incursions of exotic fruit flies. Effective surveillance programs that detect early incursions can be far more cost effective that the establishment of major eradication programs.

- ***Karnal bunt*** – an outbreak of Karnal bunt could cost Australia up to $1 billion per annum due to loss of export markets and downgrading of grain quality. These potential trade effects are very real—In 2004, Australian wheat exports to Pakistan were disrupted when Karnal bunt was erroneously identified in a shipment. The perception of presence resulted in the halting of market access by many countries. In addition the short term impact on intensive livestock production could be significant. In a recent case study on the impact of Karnal Bunt on South Australia (PIRSA, 2015), one of the most significant impacts was determined to be the impact on food supply for intensive poultry and piggery production. These facilities generally only hold 1-2 days of food supply and any interruption to the regular supply of food would generate a significant animal welfare issue. These consequential impacts of plant pest incursions need to be considered in a broad RD&E context.
- ***Fodder and pasture pests*** - pests of fodder and pasture impact on a wide range of stakeholders. Fodder (e.g. lucerne, oaten hay, ryegrass and subterranean clover) has many uses, being an essential input for animal industries (e.g. dairy industry, beef cattle producers, sheep producers, feedlots and the horse industry) as well as being used in horticulture for mulches and erosion control. Pastures are used for animal grazing and hay production as well as broadacre crop production where they are utilised to improve cropping rotations. The value of pastures to livestock industries has been estimated at $12.3 billion annually. This has been compared with the values of pastures to grain production at a relatively low figure of $654 million annually (Gout and Jones, 2006). The introduction of a new pest that impacts fodder and pasture industries would therefore have flow on effects to many other end-users, with at least 30 stakeholder groups identified as being affected in a recent Rural Industries and Research and Development Corporation (RIRDC) report (Slattery and Taylor, 2012).
- ***Varroa mite impacts on bees and pollination services*** – many plant industries rely on European honey bees to boost yields by crop pollination and some industries (e.g. almonds) are 100 percent reliant on honey bees for pollination. An incursion of the Varroa mite in Australia would seriously affect European honey bee colonies (Goodwin and Van Eaton, 2001) as well as unmanaged or feral European honey bees that currently provide free pollination services to a large number of Australian crops. The entry of Varroa into Australia would therefore have serious impacts not only on the honey bee industry but also the plant industries that rely on them. In 1999 – 2000 the value of pollination services from honey bees in Australia was estimated at $1.7 billion annually. These loses would be ongoing until the honey bee pollination industry could rebuild the number of hives needed to service this industry and interstate trade restrictions managed. (Hafi et al., 2012). Even if the spread of Varroa could be slowed through containment, losses are still estimated to range from $360 million to $930 million over 30 years (Hafi et al., 2012).

7.3 Australia's operational and policy framework for biosecurity

The Australian plant biosecurity system is complex, involving coordinated action by industry at all stages of the plant production chain, and by governments, researchers, communities and citizens.

The goal of a national biosecurity system is to minimise the impact of pests on Australia's economy and the community, with resources targeted to manage risk effectively across the continuum, while facilitating trade and the movement of animals, plants, people, goods, vectors and vessels to, from and within Australia.

The objectives of the national biosecurity system are to provide arrangements, structures and frameworks that:

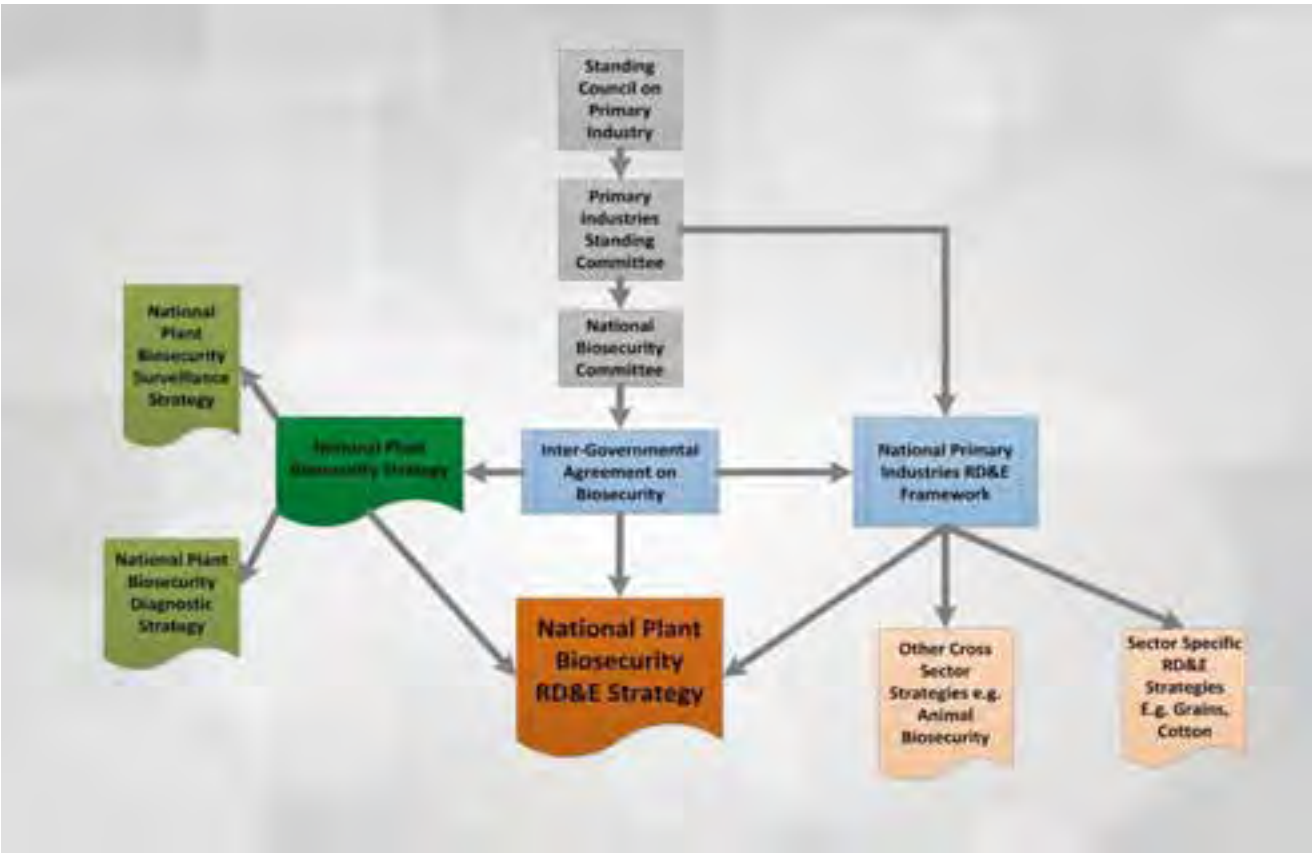
- Reduce the likelihood of exotic pests, which have the potential to cause significant harm to the economy, the environment, and the community (including people, animals and plants), from entering, becoming established or spreading in Australia.
- Prepare and allow for effective responses to, and management of, exotic and emerging pests that enter, establish or spread in Australia.
- Ensure that, where appropriate, significant pests already in Australia are contained, suppressed or otherwise managed.

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

7.3.1 Plant health policies and legislation

Some of the key policy and legislation underpinning plant biosecurity are the IGAB, the NPBS, the National Primary Industries RD&E Framework, as well as a range of Australian Government and state/territory government biosecurity legislation. The relationship between these guiding policies, the Strategy and sector-specific strategies is outlined in Figure 2.

Figure 2. Interaction between documents underpinning and guiding the Strategy



Intergovernmental Agreement on Biosecurity (IGAB)

Within government, Australia's partnership approach to biosecurity is underpinned by the IGAB[2], signed in January 2012. The IGAB strengthens the working partnership between the Australian Government and state and territory governments by defining the roles and responsibilities of governments and outlining priority areas for collaboration and to improve the national biosecurity system. Key aspects of the national biosecurity system are being addressed under the IGAB including decision making and investment, information sharing, surveillance and diagnostics, established pests, communication and engagement, preparedness and response and RD&E.

Reforms are underway with progress on building a national surveillance and diagnostic system, mechanisms to allow emergency response information to be shared between governments, and measures to improve the transparency and rigour of national decision making processes. A national framework with standardised tools to assist with communication and stakeholder engagement has also been developed and agreed. The National Biosecurity RD&E Framework (Schedule 8 of the IGAB) is an overarching framework to guide biosecurity RD&E in Australia. It has been developed with the objective of achieving *a robust and integrated national biosecurity R&D capability and infrastructure to collaboratively support the management of biosecurity risks*.

As responsibility for biosecurity management is shared, the agreement also provides opportunities for industries, natural resource managers and the community to work together to achieve some of the reforms outlined in the IGAB. This includes PHA, which has been an active contributor to this process, and has aligned the NPBS with the goals and objectives of the agreement. This alignment, as well as linkages with the Strategy (see Table 4), are critical for maintaining a consistent approach to enhancing the RD&E system in Australia.

National Plant Biosecurity Strategy

The NPBS is a comprehensive ten year plan that outlines strategies for governments, plant industries and the community to work closely together to strengthen Australia's plant biosecurity system to 2020. To develop these strategies, the views of stakeholders across Australia's plant biosecurity system were drawn together, in a process facilitated by PHA.

Importantly the NPBS was endorsed by the Australian Government, state and territory governments and PHA industry members (see Appendix 1, Table 2), which paves the way for increased cooperation between governments and plant industries in plant biosecurity. The process of implementing the recommendations began in 2011, with responsibility for guiding the implementation process divided among organisations and committees, based on their expertise. The government aspects of implementation are overseen by the Plant Health Committee (PHC), with specific input from the Subcommittee on Plant Health Diagnostic Standards (SPHDS) and the Subcommittee on National Plant Health Surveillance (SNPHS) on implementing the diagnostic and surveillance aspects, respectively.

[2] The IGAB and its schedules can be viewed at **www.coag.gov.au/node/47**

Through its implementation, the NPBS is continuing to provide the focus and strategic direction for national plant biosecurity activities and in doing so, strengthening the current plant biosecurity system.

In presenting a vision for the national plant biosecurity system, the NPBS looks at the challenges Australia will need to overcome in the next ten years and what steps will need to be taken. Realisation of this vision will better protect Australia and Australians from the negative impacts of plant pests, benefit market access for plant products, sustain Australia's high quality and reliable food supply, and preserve environmental health and amenity.

Within the NPBS, ten strategies were formulated to address the challenges and threats posed by plant pests to Australia's food security and primary production, and have been developed in alignment with biosecurity strategies of Australia's state and territory governments. These strategies are to:

- Adopt nationally consistent plant biosecurity legislation, regulations and approaches where possible within each state and territory government's overarching legislative framework.
- Establish a nationally coordinated surveillance system.
- Build Australia's ability to prepare for, and respond to, pest incursions.
- Expand Australia's plant biosecurity training capacity and capability.
- Create a nationally integrated diagnostic network.
- Enhance national management systems for established pests.
- Establish an integrated national approach to plant biosecurity education and awareness.
- Develop a national framework for plant biosecurity research.
- Adopt systems and mechanisms for the efficient and effective distribution, communication and uptake of plant biosecurity information.
- Monitor the integrity of the plant biosecurity system.

Refer to Appendix 2 for further detail on the NPBS strategies.

The Strategy has an important function to better integrate government and industry decision making and investments in plant biosecurity RD&E. It is overarched by Schedule 8 of the IGAB and will form part of a suit of sub strategies under the NPBS (see Figure 1). Other sub strategies that have been developed as part of implementation of the NPBS include the National Plant Biosecurity Diagnostic Strategy[3] and the National Plant Biosecurity Surveillance Strategy[4] (see Figure 1). Linkages with industry RD&E plans will also need to be established and maintained.

National Primary Industries RD&E Framework

The National Primary Industries RD&E Framework is intended to guide efforts to enhance the collaboration, coordination, efficiency and effectiveness of RD&E efforts nationally. In addition, continued and coordinated investment in RD&E helps to provide Australia's primary industries with the necessary capability (people, infrastructure and information) to improve their productivity, sustainability and competitiveness. The Framework is underpinned by a number of sector and cross-sector strategies, with the Strategy being one such cross-sector strategy. For further information on the Framework see section 2.1.

[3] Available from **www.planthealthaustralia.com.au/biosecurity/diagnostics/**

[4] Available from **www.planthealthaustralia.com.au/biosecurity/surveillance/**

Biosecurity legislation

Australia's biosecurity system operates under both Australian Government and state and territory legislation, and is administered and managed by the respective agricultural and environmental agencies. The legislation covers a range of activities involving domestic and international movement of people and goods into and around the country, and the export of agricultural commodities. Also contained within the legislation are other relevant functions relating to biosecurity incident response and reporting NBC Biosecurity RD&E Priorities Framework

A set of four broad national biosecurity R&D priorities that identify important under-developed and under-resourced areas of plant biosecurity research are shown in Table 2. This priorities framework has been developed by NBC and was included in the NPBS. The priorities and underpinning objectives were developed to work across the plant and animal sectors for pathogens and invasive species. They therefore articulate the high-level outcomes of R&D.

The *framework priorities* are structured around four core needs of the national biosecurity system to:

- Prevent exotic pests from entering and establishing in Australia.
- Manage the pests that are already established in Australia.
- Understand and quantify the impacts of pests.
- Demonstrate the absence of pests (to protect trade and market access).

An underlying issue common to each of the four priorities is the need for increased plant biosecurity research and development capacity and capability for the environmental and primary production sectors. Projects developed in these priority areas may deliver across more than one priority.

The *framework objectives* are structured around biosecurity system components and highlight the importance of R&D to each of the components. The objectives refer to risk assessment, risk management, detection, diagnosis, surveillance, prevention and response (including preparedness, eradication and control measures). The objectives also target scope with reference to a pre-border, border and post-border focus; and to exotic, emerging and established pests.

It is envisaged that national plant biosecurity R&D priorities will shift as research is undertaken in areas of high priority and emerging sectors. The national framework should be reviewed regularly to ensure that planning and implementation of research projects remain relevant within the priority areas.

It is important to note that industry specific priorities are developed by RDCs through their own consultative processes. They are typically set out in five year strategic plans and are based on assessments of research needs at the sectoral level.

An important consideration in developing the Plant Biosecurity RD&E strategy was the need to integrate the requirements of the PISC RD&E Framework with the requirements of the NBC R&D Working Group who have been charged with developing an implementation program for the R&D Schedule to IGAB. IGAB is a more recent high level biosecurity agreement by all governments and has a Schedule specifically covering R&D. This strategy has mapped the IGAB and PISC RD&E Framework requirements out so this strategy can meet both sets of objectives. Table 2 illustrates the NBC (IGAB) R&D Priorities.

Table 2: National Plant Biosecurity R&D Priorities Framework[5]

R&D Priorities	Objectives	Benefits
Minimise the risk of entry, establishment, or spread of exotic and emerging pests and diseases	1A. Develop the knowledge base for assessing and managing the risks of new pests and diseases, invasion pathways, and the susceptibility of ecosystems to invasion, in a changing global environment 1B. Enhance detection, surveillance and diagnostic systems 1C. Understand the sociological factors associated with the adoption or lack of adoption of risk mitigation measures by stakeholders 1D. Develop knowledge and strategies to prevent incursions and contain the spread of pests and diseases within national borders (off shore) 1E. Develop tools and decision-making capability for prevention and response 1F. Understand the risk factors that drive emergence of new pests and diseases	• More cost effective allocation of limited resources for biosecurity risk management • More cost effective responses to incursions • Economic and social benefits from quicker return to normal trade and productivity • All parties involved in the biosecurity system are committed and contribute to early warning systems • More accurate, cheaper, faster diagnosis. • More cost effective surveillance systems • More effective control or eradication of pre-border threats • Reduced risks to Australia and the region
Eradicate, control or mitigate the impact of emerging and established pests and diseases	2A. Understand the movement of pests and diseases through environments 2B. Develop effective and integrated approaches to managing established pests and diseases of national priority 2C. Improve understanding of the life history/ecology of pests and diseases and the invaded system 2D. Understand the interaction of pests and diseases with the invaded system	• Increased market access • Increased productivity • Decreased cost of control • Public health benefits (zoonotic diseases)
Understand and quantify the impacts of pests and diseases	3A. Improve understanding of the environmental, economic, and social impacts of pests and diseases and management activities 3B. Develop the knowledge base and protocols for managing the invasion risks posed by one sector for others	• More cost effective allocation of limited resources for biosecurity risk management
Cost effectively demonstrate the absence of significant pests and diseases	4A. Develop tools that can cost effectively demonstrate the absence of national priority pests and diseases including area or regional freedom	• Maintenance and growth of trade and market access • Reduced costs for disease control • Increased competitive advantage

[5] Taken from National Biosecurity Committee Document

7.3.1 Organisation of plant biosecurity systems in Australia

7.3.3.1 National committees

The Australian Government has primary responsibility for offshore and border biosecurity activities, including meeting Australia's international phytosanitary obligations, issuing export certification and trade negotiation; while the states and territories are responsible for biosecurity matters affecting their rural industries, environment and community, including surveillance, incursion and response. This division of powers responsibilities, coupled with a desire on the part of the Australian, state and territory governments to work collaboratively in developing national approaches to primary industries issues and plant biosecurity, was the catalyst for establishing the national committee framework.

The national committees provide the mechanism for consideration and decision-making of key primary industry and plant biosecurity issues within and between States. Additional linkages to other organisations involved in plant biosecurity are provided by PHA and via other established consultation mechanisms. Some of the key committees are outlined in Appendix 3.

7.3.3.2 Plant Biosecurity Research, Development and Extension

Plant biosecurity RD&E activities are conducted and coordinated to varying extents by a number of organisations including Research and Development Corporations (RDCs), Cooperative Research Centres (CRCs), the Australian Government, CSIRO, state and territory agencies as well as universities and private organisations. The complex, multi-organisational structure of RD&E activity requires coordination to ensure that, overall, there is an integrated approach to discovering and delivering the plant biosecurity science that Australia needs.

Australia invests significant resources into RD&E to ensure its biosecurity system has access to the latest technologies in a way that is applicable to its environmental conditions. Through this investment, the biosecurity system is constantly improved and the developments can be focused on the specific threats that face plant production industries in this country and other ongoing challenges associated with plant biosecurity.

RDCs

RDCs bring together industry and researchers to establish the strategic directions for R&D and to fund projects that provide industries with the innovation and productivity tools to compete in global markets. There are currently six RDCs that focus on Australia's plant production industries including Cotton Research and Development Corporation, Forest and Wood Products Australia, GRDC, Grape and Wine Research and Development Corporation, HAL and RIRDC. Dairy Australia, Australian Wool Innovation and Meat & Livestock Australia are the RDCs whose products are plant based.

RDCs do not conduct research within their organisation, but provide funding and support to research and extension providers such as state government R&D agencies, tertiary institutions, CSIRO, industry associations, agribusiness and research organisations in the private sector.

CRCs

A CRC is a company formed through a collaboration of businesses, the community, government organisations and researchers. Essential participants within a CRC must include at least one Australian end user (from either the private, public or community sector) and one Australian higher education institution (or a research institution affiliated with a university).

The CRC program is an Australian Government funded initiative. The only CRC directly related to plant production is the PBCRC. This CRC comprises 27 national and international Participant organisations across the plant biosecurity R&D continuum (see Appendix 3).

Australian Government

The Australian Government currently contributes to a variety of plant biosecurity related RD&E activities. This occurs predominately through DoA and other Australian Government departments, such as the Department of Industry, the Department of Environment and the Department of Foreign Affairs and Trade. As well as being end-users of research these departments also provide R&D funding, for example, funding for weeds R&D through the Caring for our Country Sustainable Agriculture stream.

The Australian Government statutory authorities and agencies involved in R&D include the Australian Centre for International Agricultural Research, the Australian Research Council and CSIRO. A key contribution to Australia's plant biosecurity system occurs through research undertaken within the CSIRO Biosecurity Flagship and the PBCRC (see Appendix 3).

State and territory governments

Most of Australia's state and territory agricultural departments have dedicated R&D divisions. These undertake various forms of research to support Australia's agricultural industries and focus on aspects of plant biosecurity relating to the priorities of the state or territory in question. These organisations often carry out research for commercial clients, as well as for internal government priorities. Together, these organisations deliver a significant portion of Australia's agricultural R&D.

Universities and private research institutions

Australia has universities in every state and territory that provide research and education services for the community. Within universities, research often complements local and regional issues. Research is funded by governments, industry, internal or international sources, and is often carried out in partnership with other organisations.

Private research institutes are established, often in collaboration with a university, to provide research facilities and services in relation to specific research areas. These organisations, such as Sugar Research Australia (SRA), generate and contain specialist knowledge and research skills in areas of particular significance to the Australian community and plant production industries.

Extension services

Plant biosecurity extension services are provided by industry, state and territory governments and private organisations. The provision of these services by private organisations is rapidly increasing. These services are key to facilitating the uptake of biosecurity R&D by primary producers. Extension service providers incorporate biosecurity measures across the plant production chain, for example managing on-farm pest risks.

Industries are increasingly pro-active in raising awareness and fostering uptake and adoption among their members, of biosecurity measures that are known to be cost effective. Industries are also responsible for incorporating regulated and non-regulated biosecurity measures in their quality assurance and market assurance programs.

An example of a successful extension program is the Grains Farm Biosecurity Program. Launched in 2007, the program is managed by PHA and funded by growers through Grain Producers Australia together with

the New South Wales, Queensland, South Australian, Victorian and Western Australian governments. Grains Biosecurity Officers in these five states deliver materials to raise awareness and training to growers, consultants and other industry stakeholders.

For further information on key components of Australia's biosecurity system, refer to the National Plant Biosecurity Status Report[6].

7.3.1 Major, Support, Link – National Plant Biosecurity R&D matrix

During preparation of the Strategy, an analysis of the biosecurity system was conducted to develop a list of the Major, Support and Link organisations for plant biosecurity R&D.

- **Major** indicates the agency will take a lead national role by providing significant R&D effort.
- **Support** indicates the agency will undertake R&D but no other agencies will provide the major effort.
- **Link** indicates the agency will undertake little or no R&D, instead it will access information and resources from other agencies.

It is understood that organisations will be subject to budget fluctuations and will need to adjust their Major, Support and Link status over time in areas of specialisation. This Strategy provides a vehicle to stabilise core capability and to take a collaborative approach to managing risks arising from any changes in an organisation that are likely to influence future R&D capacity.

The Major, Support, Link table was developed against each of the commodity groups covered by this Strategy and also weeds. Table 3 below shows an abridged version of the complete matrix (See Appendix 4, Table 1 for more detail). This matrix has been considered and endorsed by all state and territory agencies. If an agency identifies itself as a Major, Support or Link partner it demonstrates a commitment by the agency to support the implementation of the strategies and action items identified in the Strategy. This demonstrates the complexity of stakeholders involved and the challenges to develop fully integrated plant health and biosecurity R&D nationally.

[6] Available from **www.planthealthaustralia.com.au/national-programs/national-plant-biosecurity-status-report/**

Table 3. Summary of Major, Support and Link R&D organisations for each commodity

COMMODITY GROUPS	Qld	Vic	Tas	NT	SA	WA	NSW	CSIRO	Universities	PHA	DoA
Crops (Broad Acre)	QDAFF	DEPI Vic			SARDI	DAFWA	NSW DPI		University of Sydney, Murdoch University (SABC), La Trobe University (AgriBio), University Adelaide (Waite), Curtin University		
Horticulture (Temperate)		DEPI Vic	TIA		SARDI	DAFWA	NSW DPI		La Trobe University, (AgriBio) Murdoch University, University Adelaide (Waite)		
Horticulture (Tropical)	QDAFF			NT DPIF							
Sugar	BSES (now SRA)					DAFWA	NSW DPI				
Cotton	QDAFF					DAFWA	NSW DPI		University of New England		
Forestry	QDAFF		Forestry Tasmania			Forest Products Commission	NSW DPI		Murdoch University University of Tasmania		
Bees									University of WA, University of Sydney, UNE, University of Adelaide (Waite)		
Viticulture		DEPI Vic	TIA		SARDI	DAFWA			University of Adelaide (Waite), La Trobe University (AgriBio), Curtin University		
Nursery						DAFWA			Murdoch University		
Native Plants						DAFWA			Murdoch University University of Sydney, University of Adelaide (Waite)		
Floriculture						DAFWA					
Pastures	QDAFF				SARDI	DAFWA	NSW DPI		University Tasmania, University of Adelaide (Waite), Curtin University		
Weeds	QDAFF	DEPI Vic	TIA		SARDI	DAFWA			University of New England, Charles Stuart, University of Southern Qld, University of WA, Wollongong University, Curtin University, Melbourne University, University of Adelaide (Waite		
Fresh Water Aquatic Weeds		DEPI Vic							Murdoch University, La Trobe University (AgriBio), Curtin University		
Cross Sectoral #		DEPI Vic				DAFWA			QUT, Murdoch University, La Trobe University (AgriBio)		
Social Sciences									Charles Darwin University University of New England		

Cross sectoral includes general surveillance skills, techniques which can be applied across multiple crops e.g. infra-red screening, remote trapping, aerial spore traps etc.

Note: The ACT does not have any TI&E capacity and has not been included in this table. The ACT commercial producers utilise work undertaken by other Jurisdictions.

Major

Support

Link

8. Issues and challenges

In developing this strategy a wide range of high level strategic/policy issues relating to funding of research in Australia were taken into account. This included consideration of individual plant sector strategies, the NPBS, RDC Strategic Plans, PISC RD&E Framework and the results of the biosecurity audit. The issues and challenges identified in the following section are a summary from all the relevant documents.

8.1 Biosecurity RD&E - industry focus

Plant production industries and RDCs invest in biosecurity RD&E as part of their industry development plans. Investment principles generally focus on targeting high priority endemic pests and costs that can be mitigated through RD&E, notable exceptions being the investments in pre-emptive breeding programs for exotic grain pests.

The RD&E effort into plant biosecurity is fragmented and dispersed geographically and administratively. The current fragmentation of funding and planning allows the gradual erosion of national capability as decisions to cut funding in one sector or by one agency can place at risk critical biosecurity capability and reduce the ability to provide surge capacity during emergencies. There is a growing opinion that an overarching RD&E strategy for plant pests is required.

Primary industries and governments are looking to establish more cost effective coordination and partnership arrangements for the delivery of RD&E. Stakeholders recognise the importance of maintaining a critical mass of technical and operational expertise to meet industry and government needs, and are looking for flexible, responsive arrangements for accessing and maintaining the key expertise.

Industry-specific RD&E strategies developed under the National RD&E Framework for cotton, forestry, grains, horticulture, new and emerging industries, sugar and wine address aspects of biosecurity that are relevant to those industries. The Strategy needs to complement sectoral plans.

8.2 Changing biosecurity risks

The threat to Australia of pest incursions and ongoing spread of pests are increasing because of social and ecosystem changes and principally:

- the increased movement of plant, plant products and people as a result of globalisation
- growth in human populations and rapid urbanisation
- changing cropping patterns and land use
- climate changes.

These changes contribute to an increasing interaction between agricultural landscapes and the urban fringe.

Unfortunately, evidence suggests that Australia has an emerging critical shortage of plant biosecurity specialists. Data from a survey conducted in 2012 by two professional societies, the Australian Plant Pathology Society and Australian Entomology Society, showed that 28 percent of researchers intend retiring within the next 10 years, and 40 percent within 15 years. Additionally CSIRO estimates that if current trends continue 50 percent of Australia's biosecurity diagnostic expertise will be lost by 2028 (CSIRO, 2008), placing the nation at economic and environmental risk.

Government investment in biosecurity RD&E is forecast to decline in the short to medium term, compared to investment levels over the past decade.

8.3 Community trends

Community interest in biosecurity is increasing due to issues that impact on day to day life, for example the Red imported fire ant incursion in Queensland or Myrtle rust in eastern Australia. Plant pest incursions also impact public and private gardens, urban street tree plantings and national parks. Some of the pin oak trees forming the historic avenue of honour in Myrtleford were removed during the incursion of Chestnut blight in Victoria as they were an alternate host to Chestnut blight and within the destruction area around a known infected chestnut tree.

8.4 Government trends

Governments are focussing on developing contemporary regulatory and compliance systems to strengthen biosecurity partnerships with industry through co-regulation, co-investment and full fee services, and using government investment principles to target areas of market failure.

There is a trend to government support of pro-active industry and community groups to manage established pests by developing regulatory and non-regulatory tools and policies and providing technical expertise.

Governments are committed to improving surveillance through innovation, and delivering effective emergency preparedness and response capability. The Australian Weeds Committee (AWC) and funding mechanisms such as Caring for Our Country to identify weed surveillance and management as a priority outcome.

There is also an effort by governments to make their business systems more efficient, effective and flexible by reducing the regulatory burden and making better use of information and communication technologies.

Governments have invested in infrastructure to more effectively manage biosecurity risks by conducting the research and diagnostic activities that underpin biosecurity. However they are now faced with the challenges of maintaining both that infrastructure and the significant human capabilities required to operate them, in an environment of declining government investment over the short to medium term.

8.5 Industry trends

From an industry perspective, examples of changes affecting biosecurity risk management include:

- The changing demographics from family owned farms to multi-site company structures.
- Increasing farm size and reducing number of producers.
- Larger numbers of hobby farmers (particularly in peri-urban areas).
- More hectares per labour unit so less capacity to respond to emergency pest events.
- Economic pressures driving abandonment of orchards or vineyards resulting in increased pest threats.
- Movement of products e.g. grain, hay and livestock carry the opportunity to spread pests.
- Increased imports.

The incentives for and benefits of biosecurity are recognised at an industry level, but less so at a producer level. While some producers and large companies understand and support comprehensive quality assurance (QA) programs and the potential for integration of biosecurity measures in these programs, many others are not familiar with QA as a national process or see it as bureaucratic. In the absence of market drivers, part of the challenge in delivery of biosecurity messages will be to make the case compelling for action. Established pests continue to cause significant productivity losses and market access impediments for the plant industries. Government investment in monitoring established pests is declining with the

expectation that industry will cover the full costs. Knowledge of pest prevalence and associated costs is a driver for strengthening biosecurity measures to improve industry profitability.

8.6 Issues and challenges identified at Plant Biosecurity RD&E Strategy workshop

The high level strategic/policy issues identified during the development of this Strategy and discussed by stakeholders attending the Strategy workshop in November 2012 include:

- The RD&E system is limited by ongoing reductions in both capacity and financial resources from industry and government.
- Lack of coordination (administrative and operational) between jurisdictions, research providers, research funding providers and commodity stakeholders and all relevant RDCs to address cross-industry issues like biosecurity.
- Lack of a coherent national system for setting, reviewing, modifying and supporting RD&E Priorities ensuring maximum linkages achieved.
- Conflicting research policy that encourages and rewards competition between research providers both within the sector (institution against institution) and across sectors (within institutions) and at the same time sometimes promotes the delivery of collaborative research projects and programs between the same competing entities.
- Resource intensive research administrative and project application system that require research entities to commit significant (and sometimes unfunded) resources in project initiation and development.
- A lack of a focused process for the national assessment and distribution of research findings and project outcomes across all RD&E sectors.
- The lack of a nationally coherent system for routinely assessing the status of current capacities and infrastructure resources and matching this capacity with anticipated needs.
- Lack of systems that promote succession planning and ensure that gaps in national critical capabilities are not lost as a result of a diminishing workforce.
- A need for systems that promote research continuity that (a) avoid loss of expertise and (b) foster the development of world class research infrastructure and research outcomes.
- Strong reliance on short-term RDC funding for resourcing research activity and maintaining routine operation and stability of the national plant biosecurity system.

It is recognised that addressing some of these risks may be outside the scope of this Strategy but it was felt important to note them. The Implementation Committee may consider approaches that will minimise their impact on the delivery of outcomes from this Strategy. By addressing these issues at a high level RD&E efficiency could be increased across all strategies. To address these systemic issues would require high level cooperation with the RDCs, PISC agencies and DAFF who is the Australian Government agency responsible for government investment priorities for the RDCs.

8.7 Issues and challenges identified through the national plant biosecurity capability audit

An audit tool to gather information on national biosecurity R&D capability across multiple biosecurity sectors (plant, animal, invasive species) was developed by Animal Health Australia and PHA in 2011 with financial support from the NBC. The audit was to inform the development of the National Biosecurity RD&E Framework, the National Animal Biosecurity RD&E Strategy, Schedule 8 of the IGAB and this Strategy. A summary of the Capability Audit can be found in Appendix 5.

The audit collected information on:

- Human capability against the nationally agreed R&D priorities.
- The location and value of infrastructure investments (existing and planned).
- Levels and sources of external investment (2011) by biosecurity R&D sector and national biosecurity R&D priority area.
- Expert opinion and other relevant data from researchers and policy makers on capability needs and including for diagnostic capability.

The scope included biosecurity R&D but explicitly excluded the E (extension) and service delivery activities.

Guidelines were developed to assist the participating organisations. In the period following the audit there have been substantial changes to the national capability, in particular some state departments have cut staff that has impacted on the national capability. These cuts look to continue.

Respondents are listed in Appendix 5, Table 1. The tool was piloted with the CSIRO prior to sending to the Australian Government, state and territory departments of primary industries. Universities were invited to contribute however the response rate of this group was very low. It was noted at the time that some plant biosecurity R&D may occur outside these institutions.

The audit results and information from a 2012 survey conducted jointly by the Australasian Plant Pathology Society and the Australasian Entomology Society have been reviewed by the steering committee which developed and endorsed the following key findings.

8.7.1 Capability audit limitations

Steering Committee members noted the following limitations to the audit:

- Different approaches and interpretations of questions, scope and definitions.
- Missing data.
- Capability may be found in organisations that were not audited.
- Human capability commonly extends across disciplines, species and/or pests and the audit may not have captured this.
- The age categories limit interpretation of the extent to which an aging workforce is an issue.
- There is the potential to confound a large number (FTE or dollars) with a demand being met or the reverse, that low numbers mean there is unmet demand. For example the data show a relatively large number risk analysts employed by DAFF. However they do not conduct R&D.
- Exclusion of 'extension' from the audit scope.
- The survey did not canvas input from the RDCs.
- Questions about whether students should be considered as part of a stable Biosecurity R&D base.
- The audit is a snap shot in time. It does not show trends and is already dated. For example post audit there have been budget cuts to departments of primary industries with significant downsizing in Queensland and New South Wales and the closure in Queensland of its two regional laboratories.

8.7.2 Conclusions

The Steering Committee endorsed the following conclusions:

- In the last five years there has been major investment in biosecurity infrastructure. An ongoing challenge for this Strategy will be to maintain the infrastructure and enable efficient access as part of a co-ordinated national biosecurity system.

- The audit results, along with the analysis undertaken by the relevant professional societies indicate an ageing biosecurity workforce with two capabilities identified as at risk. A future challenge is to support a more flexible workforce capability, with flexibility extending across sites, organisations and disciplines and while maintaining a cadre of specialist expertise.
- Most of the national effort is focussed on the here and now with little future focus and the majority of the R&D effort was directed at control of established pests.
- The university sector holds key capability in epidemiology and ecology, yet it has no legislative regulatory role and no obligation to maintain biosecurity capability.
- Diagnostics is at risk due to the paucity of activity in taxonomy.
- Recognising the audit limitations, the results suggest research investment gaps in sociological research to support risk management, and improving understanding of the “triple bottom line” impacts of pests.
- A future challenge is to balance RD&E investment among the identified priority areas and to use appropriate methodology to undertake the allocation. Analysis of the flow of benefits from RD&E will be important to assist with the investment decisions.
- Priorities for extension and its integration with research and development need to be developed. An audit of extension capability should be undertaken during Strategy implementation.
- Future government investment in biosecurity RD&E is likely to be lower than 2010 levels.
- Consideration of capability should also focus on biosecurity regions in addition to jurisdictions (e.g. north and south).
- Historically, there has been a significant distributed national capability for plant biosecurity RD&E, provided mainly by states and some university faculties.
- For the future Australia needs a flexible, adaptable national system for plant biosecurity RD&E, with good information flow and recognition of the priority areas of expertise and capability.
- It is expected that as time progresses, changes in capability will be observed as resources are redeployed/trained/educated in areas that require further attention.

9. Plant Biosecurity RD&E Strategies

The issues and challenges identified in Section 6 informed the development of 7 priority strategic responses providing a high level framework for the Implementation Committee. The strategic responses are listed below and are summarised in Table 4 along with the plant biosecurity challenges and linkages to the relevant NPBS policy framework.

1. Monitor key activities in plant biosecurity R&D including reviewing the ongoing capability review process so that the integrity of the biosecurity system can be maintained and ensure skills across all disciplines are maintained in support of the national effort. Conduct a national plant industries R&D stocktake on a regular basis. Use the stocktake to identify gaps in research, the areas for collaboration and to inform the refinement of plant biosecurity RD&E priorities

2. Identify and prioritise RD&E areas in plant biosecurity including (but not limited to);

I. Developing national RD&E programs with consideration to developing a mechanism to ensure that fundamental research is a significant component of the national plant biosecurity R&D effort,
II. Developing a commissioned research plan, which includes a feedback mechanism, to underpin succession planning for key staff or disciplines,
III. Ensuring funding providers consider the impact of endemic pest R&D on preparedness for exotic incursions.

Develop tools to assist in analysing existing data sources such as the National Plant Biosecurity Status Report to identify gaps in research and the areas for collaboration to refine the priorities of plant biosecurity RD&E. Ensure linkage to the work being undertaken under Strategy 8 of the NPBS (see Table 4) as well as the nationally endorsed strategies such the National Plant Biosecurity Diagnostic and Surveillance Strategies, the IGAB RD&E Framework and the Australian Weeds Strategy. Linking to these nationally endorsed strategies ensures both industry and government are engaged in the priority setting process.

In determining national priorities, the Implementation Committee must ensure those developing the nationally agreed plant biosecurity RD&E priorities also use key source documents such as planning outputs from government agencies (eg state and territory Strategic Plans), industry (eg Industry Strategic Plans, Industry Investment Strategies, Industry Biosecurity Plans), RDCs (eg GRDC Investment Plan 2013 -14) and overseas research to identify national plant biosecurity research priorities.

Development of an ongoing integrated capability review process so that the integrity of the biosecurity system can be maintained and ensure skills across all disciplines are maintained in support of the national effort. For example if a bacterial specialist is lost due to lack of interest/succession and there is an incursion of an exotic bacterial pest, how is the relevant research done? There is a need to plan for loss of capability and that may mean an agreement with an interstate agency to assist. To actively manage national capability, jurisdictions need to be aware of each-others capability, in particular the loss of vulnerable capability. This way they can make capability decisions that are cognisant of decisions made by other jurisdictions. Ongoing auditing of capability (including the university and private sectors) will assist identification of gaps and vulnerabilities in RD&E capability. There is also a need for succession planning and capability building as postgraduates and postdoctoral research capability is low (see Appendix 5, section 5.3). It takes up to ten years to fully train researchers and in order to both attract and retain capability there needs to be investment in long term career structures. In determining capacity, international linkages should be considered as capacity does not always have to be located in Australia. This plan should link to the work being undertaken under Strategy 5 of the NPBS (see Table 4).

There are lessons that can be learnt and findings that can be used across pests and industries. These should be captured as part of the process identified in Strategic Response 1 and 2 above. Although the majority of R&D is performed on endemics, this capability and knowledge is used for exotics R&D.

3. Conduct an annual national stakeholders workshop to contribute to the determination of priorities for for plant biosecurity RD&E. Research effort is not currently being applied where the RDCs and government priorities are ranked through their strategic priorities (for example, see Appendix 5, Tables 2 to 7). Therefore, once priorities are determined, there needs to be an ongoing process for assessing whether R&D activities are providing adequate coverage of the priorities. The Implementation Committee should have a national workshop each year at which stakeholders discuss and set priorities for plant biosecurity RD&E. This meeting should also be used to identify and cross link sector specific RD&E that has benefits to the broader plant biosecurity community.

4. Develop a dynamic mechanism for collating and providing strategic plant biosecurity information, R&D priorities and infrastructure needs to key stakeholders, eg funding bodies and research providers. Strengthen internal partnerships within agencies, between researchers (R&D providers), RDCs, governments and other stakeholders. Build on existing collaboration and support long-term multi-agency programs. Currently discipline capability is scattered across multiple organisations (Appendix 5, Table 8), highlighting the importance of collaboration and coordination of R&D activities between organisations. When established these partnerships can develop long term programs supported by funders and end users alike. This will provide certainty to RD&E providers but at the same time provide a pathway to adoption via the involvement of the end users of the R&D.

Ensure that the basic research is being undertaken (known as 'blue sky' research) otherwise there will be no ability to do applied research in the future. The CSIRO Biosecurity Flagship has transformational R&D in their stated aims and they could be listed as a major for 'blue sky' R&D in the plant biosecurity sector.

5. Support R&D funding directed towards national centres of excellence for plant biosecurity research (eg Major, Support, Link, Table 3). Review national infrastructure to determine the need and opportunity for specialisation in either a discipline or commodity. Include a process that ensures research needs are aligned to operational needs to support both the operations and the implementation of the research. Ensure policy does not inhibit the delivery of research. Link to the work being undertaken under Strategy 5 of the NPBS (see Table 4).

6. Develop systems and strategies for the efficient storage, effective distribution and uptake of R&D knowledge and outcomes. Develop arrangements for the efficient delivery of R&D outcomes built into Extension activities both public and private. Strategically assess all data and the usefulness and impact of the work done. Develop communication strategies as part of R&D projects to encourage active engagement with "E" practitioners e.g. crop scouts, consultants, trade providers. There is a need to include defined end objectives for each applied R&D project (i.e. publish, develop an extension strategy).

It should be recognised that the 6 priority strategic responses are not of equal importance. The Implementation Committee will undertake an assessment of the need and urgency of action against the strategic responses in developing their work plan. In addition, as implementation of the Strategy progresses, some of the strategic responses may become redundant while new areas are added. In order for the Strategy to be effective it needs to be a living and evolving document.

Table 4. Summary of Plant Biosecurity RD&E Strategy Responses

Plant Biosecurity RD&E Challenges (Summary)	NPBS Policy Framework Reference[7]	Strategic Responses for Consideration by the Implementation Committee
Large number of stakeholders and wide range of pest threats prevent cohesive and detailed perspective of RD&E needs	**NPBS Strategy 8, Recommendation 14, Action 14.1:** Conduct a national plant industries R&D stocktake on a regular basis **NPBS Strategy 10, Recommendation 16:** Monitor the integrity of the plant biosecurity system in conjunction with, and on behalf of, all stakeholders, through PHA	**1 Monitor key activities in plant biosecurity R&D** Monitor the integrity of the plant biosecurity system in conjunction with, and on behalf of, all stakeholders through PHA. Conduct a national plant industries R&D stocktake on a regular basis. Use the stocktake to identify gaps in research, the areas for collaboration and to inform the refinement of plant biosecurity RD&E priorities.
Fragmented RD&E – dispersed geographically and administratively. Capacity resides in government, university and private sectors Emphasis on applied research - little focus on 'blue sky' research	**NPBS Strategy 8, Recommendation 14, Action 14.2:** Identify and prioritise key R&D areas in plant biosecurity	**2 Identify and prioritise key RD&E areas in plant biosecurity** Develop tools to assist in analysing the existing data sources such as the National Plant Biosecurity Status Report to identify gaps in research and the areas for collaboration to refine the priorities of plant biosecurity RD&E. Ensure linkage to the work being undertaken under Strategy Eight of the NPBS as well as the nationally endorsed strategies such the NPBS, National Plant Biosecurity Diagnostic and Surveillance Strategies, the IGAB RD&E Framework and the Australian Weeds Strategy. **2 (i) Develop a mechanism that ensures that fundamental research is a significant component of the national plant biosecurity R&D effort** Ensure that fundamental research is being undertaken (known as 'blue sky' research) otherwise there will be no ability to do the applied research in the future. The CSIRO Biosecurity Flagship has transformational R&D in their stated aims and they could be listed as a major for 'blue sky' R&D in the plant biosecurity sector.

[7] See Appendix 2 for full descriptions of NPBS Strategies, Recommendations and Actions

Plant Biosecurity RD&E Challenges (Summary)	NPBS Policy Framework Reference[7]	Strategic Responses for Consideration by the Implementation Committee
Ageing biosecurity RD&E workforce – lack of national coherent succession planning Difficulty in maintaining flexible response arrangements Paucity of activity in some R&D disciplines e.g. Taxonomy and sociology Reliance of RD&E capability for response surge capacity	**NPBS Strategy 4, Recommendation 7, Action 7.1:** Develop a national training framework (at both tertiary and vocational levels) to fill existing and anticipated future skill gaps **NPBS Strategy 4, Recommendation 7, Action 7.2:** Assessment and appropriate allocation of Australian Research Council and RDC funding that contributes to the training of Australian scientists in plant biosecurity related disciplines **NPBS Strategy 4, Recommendation 7, Action 7.3:** Link undergraduate and postgraduate scholarships to industry and government employment opportunities **NPBS Strategy 5, Recommendation 8, Action 8.4:** Key roles and responsibilities agreed amongst agencies on a nationally coordinated basis **NPBS Strategy 5, Recommendation 8, Action 8.6:** Develop a process to encourage new diagnosticians to enter the field and enable continued professional development of current diagnosticians **NPBS Strategy 5, Recommendation 9, Action 9.1:** Develop a network of plant biosecurity diagnostic laboratories that have the ability to deliver diagnostic testing to the quality required by the customer **NPBS Strategy 5, Recommendation 9, Action 9.2:** Governments to take responsibility for establishment and ongoing costs of maintaining appropriate quality systems for diagnostic laboratories **NPBS Strategy 4, Recommendation 7, Action 7.4:** Develop a mechanism to generate surge capacity in laboratory and operational staff in the event of an Emergency Plant Pest incursion	**2 (ii) Develop a commissioned research plan which includes a feedback mechanism, to underpin succession planning for key staff or disciplines** There is also a need for succession planning and capability building as postgraduates and postdoctoral research capability is low (see Appendix 5, section 5.3). It takes up to ten years to fully train researchers and in order to both attract and retain capability there needs to be investment in long term career structures. In determining capacity, International linkages should be considered as capacity does not always have to be located in Australia For example if a bacterial specialist is lost due to lack of interest/succession and there is an incursion of an exotic bacterial pest, how is the relevant research done? There is a need to plan for loss of capability and that may mean an agreement with an interstate agency to assist. To actively manage national capability, jurisdictions need to be aware of each-others capability, in particular the loss of vulnerable capability. This way they can make capability decisions that are cognisant of other jurisdictions decisions. Ongoing auditing of capability (including the university and private sectors) will assist identification of gaps and vulnerabilities in RD&E capability. **2 (iii) Ensure funding providers consider the impact of endemic pest R&D on preparedness for exotic incursions** There are lessons that can be learnt and findings that can be used across pests and industries. These should be captured as part of the process identified in Strategic Response 1 & 2 above. Although the majority of R&D is performed on endemics, this capability is utilised for exotics R&D.

Plant Biosecurity RD&E Challenges (Summary)	NPBS Policy Framework Reference[7]	Strategic Responses for Consideration by the Implementation Committee
Fragmented funding system – divided along industry lines	**NPBS Strategy 4, Recommendation 7, Action 7.5:** Instigate annual plant biosecurity workshops to enable professional networking and information exchange **NPBS Strategy 5, Recommendation 8, Action 8.4:** Key roles and responsibilities agreed amongst agencies on a nationally coordinated basis **NPBS Strategy 8, Recommendation 14, Action 14.2:** Identify and prioritise key R&D areas in plant biosecurity	**3 Conduct an annual national workshop for stakeholders to contribute to the determiniation of priorities for plant biosecurity RD&E** Research effort is not currently being applied where the RDCs and Government priorities are ranked through their strategic priorities. Therefore, once priorities are determined, there needs to be an ongoing process for assessing whether R&D activities are providing adequate coverage of the priorities. The Implementation Committee should have a national workshop each year where the stakeholders can discuss and set priorities for plant biosecurity RD&E. This meeting should also be used to identify and cross link sector specific RD&E that has benefits to the broader plant biosecurity community.
Current plant biosecurity research initiatives developed and guided by a wide range of stakeholders	**NPBS Strategy 4, Recommendation 7, Action 7.5:** Instigate annual plant biosecurity workshops to enable professional networking and information exchange **NPBS Strategy 8, Recommendation 14, Action 14.2:** Identify and prioritise key R&D areas in plant biosecurity	**4 Develop a dynamic mechanism for collating and providing strategic plant biosecurity information, R&D priorities and infrastructure needs to key stakeholders, eg funding bodies and research providers** There needs to be an ongoing process for assessing whether R&D activities are providing adequate coverage of the priorities. This could be implemented as part of Strategic Response 1 to monitor the integrity of the plant biosecurity system.
Declining government investment. Challenges in maintaining existing and new RD&E infrastructure Cuts in sectors have potential to reduce critical national RD&E capacity and infrastructure	**NPBS Strategy 5, Recommendation 9, Action 9.1:** Develop a network of plant biosecurity diagnostic laboratories that have the ability to deliver diagnostic testing to the quality required by the customer **NPBS Strategy 5, Recommendation 9, Action 9.2:** Governments to take responsibility for establishment and ongoing costs of maintaining appropriate quality systems for diagnostic laboratories	**5 Support R&D funding directed towards national centres of excellence for plant biosecurity research (eg Major, Support, Link, Table 3)** Review national infrastructure to determine the need and opportunity for specialisation in either a discipline or commodity. Include a process that ensures research needs are aligned to operational needs to support both the operations and the implementation of the research. Ensure policy does not inhibit the delivery of research.

Plant Biosecurity RD&E Challenges (Summary)	NPBS Policy Framework Reference[7]	Strategic Responses for Consideration by the Implementation Committee
Inability to efficiently review, extend, distribute, communicate & adopt outputs from plant biosecurity R&D	**Strategy 4, Recommendation 7, Action 7.5:** Instigate annual plant biosecurity workshops to enable professional networking and information exchange **Strategy 7, Recommendation 13, Action 12.2:** When developing plant biosecurity operational and extension plans, ensure specific stakeholder needs are taken into account **Strategy 7, Recommendation 13, Action 13.1:** Community engagement strategies should be supported with infrastructure that enables feedback and follow up to be provided to community participants, delivering wider community engagement and valuable plant biosecurity information **NPBS Strategy 9, Recommendation 15, Action 15.3:** Develop systems and strategies for efficient storage, effective distribution and uptake of R&D outcomes	**6 Develop systems and strategies for efficient storage, effective distribution and uptake of R&D knowledge and outcomes** Develop arrangements for the efficient delivery of R&D outcomes built into Extension activities both public and private. Strategically assess all data and the usefulness/impact of the work done. Develop communication strategies as part of R&D projects which encourage active engagement with 'E' practitioners e.g. crop scouts, consultants, trade providers. There is a need to include defined end objectives for each applied R&D project (i.e. publish and develop an extension strategy).

10. Implementation of the Strategy

Implementation will involve setting up the structures and process by which the biosecurity sector will:

- Develop, implement and evaluate Australia's long-term strategic cross-sector plant biosecurity RD&E needs and priorities.
- Promote and facilitate collaboration.
- Monitor Australia's RD&E capability.
- Implement, evaluate and report on the impact of the Strategy to government, industry and the community.

10.1 Model

The successful implementation of this Strategy will require:

- Effective linkages between plant biosecurity RD&E investors, providers and end-users/research adopters.
- Integration between this Strategy and sector specific strategies and the IGAB.
- A dedicated budget for administering the Strategy.
- The commitment of stakeholders to make it work including co-investment in agreed priority areas.

The proposed structure is comprised of the National Plant Biosecurity RD&E Implementation Committee and a Coordinator.

10.2 National Plant Biosecurity RD&E Implementation Committee

10.2.1 Terms of Reference

The National Plant Biosecurity RD&E Implementation Committee will undertake the following roles:

- Undertake the role of Strategy custodian.
- Provide strategic oversight and direction for the implementation of the Strategy.
- Develop a 5 year working plan with KPIs to monitor progress and implement the plan. This working plan needs to include a review of the entire plan to ensure it remains current and contempory.
- Coordinate, as required, capability audits of RD&E providers.
- Initiate and convene an annual national plant biosecurity RD&E forum/workshop.
- Guide implementation and review of the Strategy.
- Provide representation to high-level decision-making biosecurity bodies.
- Enhance knowledge and capacity-building within and across the plant biosecurity sector.
- Provide a vehicle for the consultation, coordination and communication between plant biosecurity stakeholders.
- Facilitate the development of a national RD&E program and centres of excellence.
- Facilitate the communication of RD&E outcomes to the primary industries sector, general public and policy makers.
- Identify priorities in approaches, directions, benefits and develop business cases as appropriate.
- Report to the PISC RD&E Steering Committee and Strategy stakeholders as required.
- Sub-committees or working groups may be formed at the committee's discretion.

10.2.2 Membership

Membership of the Implementation Committee will be voluntary and will comprise representatives from all stakeholder groups including, but not restricted to:

- 1 representative from the Australian Government accountable for plant biosecurity
- Representative from each state and territory (if the agency elects to provide a representative) with the Committee comprising a mix of representative accountable for plant biosecurity and R&D.
- Representatives from the RDCs who are investors in the Strategy
- 2 university representatives
- 1 PHA representative
- 1 PBCRC representative
- 1 CSIRO Biosecurity Flagship representative.

It is envisaged that an Iindependent Chair would be sought to guide the Implementation Committee.

10.2.3 Modus Operandi

It is envisaged that the Implementation Committee would meet on a regular basis as determined by the Chair. Membership of the Implementation Committee will be voluntary, participatory and offer opportunities to negotiate RD&E activities that will benefit all plant biosecurity stakeholders.

Members will fund their own costs of attending meetings.

Sub-committees or working groups may be formed at the committee's discretion.

10.3 Coordinator

The National Plant Biosecurity RD&E Implementation Committee will be responsible for nominating a coordinator.

The role of the coordinator will be to:

- Assist the Implementation Committee to develop and implement the strategic directions and annual work plan.
- Provide administrative support to the Implementation Committee.
- Ensure linkages with other strategies are maintained.
- Maintain communication linkages with all stakeholders.

The coordinator will be accountable to the Implementation Committee.

Stakeholders' support for the coordinator will be sought from the government sponsor with industry support being sought through the relevant RDCs. The support for this function and role will be undertaken in parallel with the approval process for the Strategy and is considered vital in order to effectively implement the Strategy.

Feedback during the development of the Strategy, from the Strategy Steering Committee and the PISC RD&E Steering Committee, is that for a strategy to be successfully implemented executive support will be required.

10.4 Strategy Administration

The implementation of the Strategy will be administered by the coordinator and the Implementation Committee. The role of coordinator will be fully costed as per an approved budget.

10.5 Funding

There will be a shared funding model determined through the PISC R&D Sub-Committee for implementation of the Strategy. This funding will cover the costs for the coordinator role, Independent Chair, annual committee meetings, working group costs, the annual forum and travel expenses.

11. Consultation and approvals

This Strategy was approved by SCoPI on 15 December 2013. In gaining approval, the draft Strategy was endorsed by the stakeholders listed in Appendix 1, Table 3, recommended by the PISC RD&E Sub-committee prior to submission to the Standing Committee endorsement process and supported by the industry members of PHA.

Consultation with the aforementioned stakeholders was managed through the N ational Steering Committee during the Strategy development process.

12. Commencement and work plan

It is widely acknowledged that the Strategy will continue to evolve over time, with regular updates on activities undertaken and provided to the PISC RD&E Subcommittee and other stakeholders either through face-to-face meetings or via electronic means.

A number of activities have been identified by the Steering Committee as requiring priority attention by the coordinator and Implementation Committee:

- appointment of the coordinator and Independent Chair of the Implementation Committee
- a national extension capability audit
- a review of the R&D capability audit
- an annual work plan based on the Implementation Committee's terms of reference
- promotion of the Strategy among all stakeholders to gain 'buy-in'.

13. References

Australian Bureau of Statistics (2012), 2012 Year Book Australia, cat. no. 1301.0, ABS, Canberra.

Commonwealth Scientific and Industrial Research Organisation (2008), Review of Australia's Quarantine and Biosecurity Arrangements. CSIRO Submission 08/283. Commonwealth Scientific and Industrial Research Organisation, Canberra.

Goodwin M and Van Eaton V (2001), Control of Varroa – a guide for New Zealand beekeepers. Wellington, New Zealand.

Gout M and Jones S (2006), The value of pastures in Groundcover Issue 62- Pasture Supplement, publisher Coretext, Melbourne.

Hafi A, Millist N, Morey K, Caley P and Buetre B (2012), A benefit-cost framework for responding to an incursion of Varroa destructor. ABARES Research Report 12.5.

Primary Industries and Regions South Australia (2015), Karnal bunt Response Plan Draft, PIRSA.

Slattery J and Taylor S (2013), Stakeholder map and Industry Biosecurity Plan for lucerne, oaten hay, ryegrass and subterranean clover. RIRDC Publication No. 12/134, RIRDC Project No. PRJ-005645.

Appendix 1. Record of stakeholder engagement in Strategy development

Appendix 1 Table 1. Attendees of the Plant Biosecurity RD&E Strategy Workshop, November 2012

Attendee	Organisation
Ashley Zamek	PHA
Barry Croft	BSES (now SRA)
Cameron Allen	MLA
Darryl Barbour	DAFF
David Guest	University of Sydney
Deborah Hailstones	NSW DPI
Felicity Andriunas	PHA
Greg Fraser	PHA
Greg Kauter	Cotton Australia
John de Majnik	RIRDC
Kathy Ophel Keller	SARDI
Mark Panitz	QDAFF
Martin Barlass	DEPI Vic
Mike Cole	DAFF
Nicholas Woods	PHA
Nick Langley	PBCRC
Paul De Barro	CSIRO
Rod Turner	PHA
Rohan Rainbow	GRDC
Stephen Dibley	PHA
Vanessa Findlay	DAFF

Appendix 1 Table 2. Stakeholders that endorsed the National Plant Biosecurity Strategy

Apple and Pear Australia Ltd	DEPI Vic
Australasian Plant Pathology Society	DPIPWE
Australian Banana Growers' Council	Dried Fruits Australia (formerly Australian Dried Fruits Association)
Australian Forest Products Association (formerly Australian Plantation Products and Paper Industry Council)	Grain Producers Australia Ltd.
Australian Honey Bee Industry Council	GRDC
Australian Lychee Growers' Association	GROWCOM
Australian Macadamia Society	HAL
Australian Mango Industry Association Ltd.	New Rural Industries Australia
Australian Nut Industry Council	NSW DPI
Australian Olive Association Ltd.	NT DPIF
Australian Processing Tomato Research Council Inc.	Nursery and Garden Industry Australia
Australian Table Grape Association	Onions Australia
Australian Walnut Industry Association	Passionfruit Australia Inc. (formerly Australian Passionfruit Industry Association)
AUSVEG Ltd.	PBCRC
Avocados Australia	PIRSA
CANEGROWERS	QDAFF
Canned Fruit Industry Council of Australia	Ricegrowers' Association of Australia Inc.
Cherry Growers of Australia Inc.	Strawberries Australia Inc.
Citrus Australia	Sugar Research Australia (formerly BSES Ltd.)
Cotton Australia	Summerfruit Australia Ltd.
Cotton Research and Development Corporation	Territory and Municipal Services, Australian Capital Territory
DAFWA	Wine Grape Growers' Australia

Key stakeholders involved in the national biosecurity RD&E Capability audit are identified in Appendix 5, Table 1. Members of the Strategy Steering Committee are listed in the Acknowledgements, page 2.

Appendix 2. NPBS Strategies, Recommendations and Actions

Strategy 1	Adopt nationally consistent plant biosecurity legislation, regulations and approaches where possible within each state and territory government's overarching legislative framework
Recommendation 1	**Establish a framework for plant biosecurity legislation that promotes harmonisation and consistency of regulation for trade in plants and plant products within Australia, in accord with the principles of domestic trade and Australia's international rights and obligations**
Action 1.1	Establish an agreed, nationally consistent risk assessment method for trade in plants and plant products in accordance with International Plant Protection Convention International Standards for Phytosanitary Measures No. 2 (Framework for Pest Risk Analysis)
Action 1.2	Address complex, inconsistent legislative processes and language via the development of a framework that delivers nationally consistent approaches to the biosecure trade of plants and plant products in Australia
Action 1.3	Ensure that legislation and agreements are in place to meet all Emergency Plant Pest Response Deed requirements and that bilateral/multilateral arrangements are in place to remove any impediments to cross border emergency responses
Action 1.4	Align domestic and international market access policy and operations to identify and capture efficiencies in their delivery through integrated export systems and processes
Action 1.5	Review domestic and international phytosanitary certification processes for the movement of plants and plant products, focusing on the national adoption of electronic systems for certification by government inspectors and by businesses accredited under approved schemes
Action 1.6	Develop a process for government and industry education and training on regulatory processes and obligations at national and international levels
Recommendation 2	**Provide resources and appropriate processes to ensure the development and implementation of nationally consistent plant biosecurity legislation and regulations**
Action 2.1	State and territory governments commit sufficient resources to implement the actions recommended under this strategy
Strategy 2	**Establish a nationally coordinated surveillance system**
Recommendation 3	**Facilitate the development of a nationally coordinated and targeted surveillance system that provides intelligence, supports the early detection of exotic plant pests, reports evidence of area freedom, enhances pest incursion responses and supports the effective management of established pests**
Action 3.1	Establish nationally agreed standards and plans for the collection of surveillance data for priority plant pests for the purposes of early detection and market access

Action 3.2	Establish a national surveillance coordination centre with responsibility for reviewing the national design, collection, capture and analysis of data
Action 3.3	Establish a mechanism to engage industry, regions and communities to ensure broader recognition of the importance of surveillance and collection of surveillance data
Action 3.4	National surveillance protocols should be developed and linked with Quality Assurance systems and accreditation to act as a driver for creating capacity and capability
Strategy 3	**Build Australia's ability to prepare for and respond to pest incursions**
Recommendation 4	**Continue to review and improve emergency response efficiency and effectiveness through improved processes, decision making, education, training and accreditation of personnel**
Action 4.1	Continually review and improve joint industry and government decision making and response management arrangements to ensure they are rapid, collaborative, clear, effective, efficient and meet stakeholder expectations
Action 4.2	Gain national commitment to ensure emergency response training is available, delivered at the appropriate frequency and meeting role needs
Action 4.3	Increase efficiency by identifying and addressing gaps and overlaps in responsibilities of relevant national, state, territory and regional authorities in emergency management roles
Action 4.4	Develop a nationally agreed approach where eradication is technically not feasible
Action 4.5	Develop forecasts of expected production by plant industries as a biosecurity risk management, preparedness and response tool
Action 4.6	Stakeholders provide resources to ensure that baseline capacity is sufficient to meet normal commitments under the Emergency Plant Pest Response Deed and similar instruments, through the development of normal commitments benchmarks, performance standards and regular reporting
Action 4.7	Develop pre-agreed, risk based national response and cost sharing arrangements for pests not covered by existing arrangements
Recommendation 5	**Develop contingency plans or business continuity plans covering all High Priority Pests**
Action 5.1	Develop contingency plans or business continuity plans for all identified High Priority Pests with the allocation of agreed national roles and responsibilities
Recommendation 6	**Develop a national risk based decision making and investment framework that guides the efficient allocation of plant biosecurity resources, maximising return on investment and establishing a transparent and objective decision making process**

Strategy 4	Expand Australia's plant biosecurity training capacity and capability
Recommendation 7	**Maintain and enhance Australia's plant biosecurity training capability and capacity to underpin the ongoing needs of the national plant biosecurity system**
Action 7.1	Develop a national training framework (at both tertiary and vocational levels) to fill existing and anticipated future skill gaps
Action 7.2	Assessment and appropriate allocation of Australian Research Council and Research & Development Corporation funding that contributes to the training of Australian scientists in plant biosecurity related disciplines
Action 7.3	Link undergraduate and postgraduate scholarships to industry and government employment opportunities
Action 7.4	Develop a mechanism to generate surge capacity in laboratory and operational staff in the event of an Emergency Plant Pest incursion
Action 7.5	Instigate annual plant biosecurity workshops to enable professional networking and information exchange
Strategy 5	**Create a nationally integrated diagnostic network**
Recommendation 8	**Develop a nationally integrated plant biosecurity diagnostic network that underpins Australia's plant biosecurity system**
Action 8.1	Establish a nationally integrated plant biosecurity diagnostic network
Action 8.2	Establish a harmonised approval process for the transfer of suspect and confirmed samples of priority plant pests between laboratories
Action 8.3	Establish an integrated and coordinated network of diagnostic centres based on Australia's climatic zones
Action 8.4	Key roles and responsibilities agreed amongst agencies on a nationally coordinated basis
Action 8.5	Design and develop a National Plant Biosecurity Diagnostic Strategy within the National Plant Biosecurity Strategy framework, which identifies key goals, objectives, timelines and resource requirements
Action 8.6	Develop a process to encourage new diagnosticians to enter the field and enable continued professional development of current diagnosticians
Recommendation 9	**Implement, maintain and manage appropriate quality management systems in plant biosecurity laboratories undertaking diagnostic testing**
Action 9.1	Develop a network of plant biosecurity diagnostic laboratories that have the ability to deliver diagnostic testing to the quality required by the customer
Action 9.2	Governments to take responsibility for establishment and ongoing costs of maintaining appropriate quality systems for diagnostic laboratories
Recommendation 10	**Endorsed National Diagnostic Protocols for all High Priority Pests be developed and maintained**

Action 10.1	Regularly prioritise diagnostic protocols for development and review using a contemporary risk based approach
Action 10.2	Develop a national policy to facilitate access to reference material and positive controls for diagnostic tests by ensuring appropriate processes and containment protocols are in place for their importation, storage and handling
Strategy 6	**Enhance national management systems for established pests**
Recommendation 11	**Enhance the national management system for established pests**
Action 11.1	Develop a nationally integrated approach for management of significant established pests that consolidates information into national data sets
Action 11.2	Establish systems to accurately determine the cost of pest management operations and guide the effective allocation of resources
Action 11.3	Develop national decision making support tools that can assess the likely spread and impact of established species and determine shifts in pest risk profiles
Action 11.4	Integrated Pest Management should be encouraged where applicable as the baseline for established pest management operations
Action 11.5	Promote and facilitate active development and introduction of new plant varieties using both traditional breeding and other plant biotechnology techniques (including genetic modification), where consistent with state and territory legislation, that are resistant to pest attack and better adapted to regions subject to climate change and variability
Strategy 7	**Establish an integrated national approach to plant biosecurity education and awareness**
Recommendation 12	**Develop an integrated national approach to plant biosecurity communication between all key stakeholders**
Action 12.1	Use Industry Biosecurity Plans and other relevant documents as a base to establish and develop specific sectoral awareness packages
Action 12.2	When developing plant biosecurity operational and extension plans, ensure specific stakeholder needs are taken into account
Action 12.3	Through the National Communications Network develop a National Biosecurity Communication Strategy
Recommendation 13	**Processes need to be defined that identify, engage, evaluate and sustain community engagement and capture plant biosecurity information**
Action 13.1	Community engagement strategies should be supported with infrastructure that enables feedback and follow up to be provided to community participants, delivering wider community engagement and valuable plant biosecurity information
Action 13.2	Develop processes that support the identification and characterisation of small and large agricultural enterprises in Australia

Strategy 8	**Develop a national framework for plant biosecurity research**
Recommendation 14	**Establish a national framework for plant biosecurity research**
Action 14.1	Conduct a national plant industries research and development stocktake on a regular basis
Action 14.2	Identify and prioritise key research and development areas in plant biosecurity
Strategy 9	**Adopt systems and mechanisms for the efficient and effective distribution, communication and uptake of plant biosecurity information**
Recommendation 15	**Establish a national plant biosecurity information management framework to optimise data sharing**
Action 15.1	Develop, implement and maintain standardised information systems nationally, both within government and industry, for the collection, analysis and retrieval of surveillance data
Action 15.2	Develop a system that enables the sharing of diagnostic data nationally and complete a stocktake of existing data management systems in plant biosecurity laboratories
Action 15.3	Develop systems and strategies for efficient storage, effective distribution and uptake of research and development outcomes
Action 15.4	Ensure that existing data systems of relevance to plant biosecurity are linked to future systems
Strategy 10	**Monitor the integrity of the plant biosecurity system**
Recommendation 16	**Monitor the integrity of the plant biosecurity system in conjunction with, and on behalf of, all stakeholders, through Plant Health Australia**
Recommendation 17	**Develop an implementation plan for the delivery of the National Plant Biosecurity Strategy in conjunction with, and on behalf of, all stakeholders, through Plant Health Australia**
Action 17.1	A National Plant Biosecurity Strategy Implementation Committee be established to develop an action plan that can direct the implementation of the National Plant Biosecurity Strategy in accordance with the recommendations and actions presented within the strategy

Appendix 3. Other key initiatives and linkages impacting on plant biosecurity RD&E

PHA

PHA is the national coordinator of the government-industry partnership for plant biosecurity in Australia. As a not-for-profit company, PHA services the needs of its Members and independently advocates on behalf of the national plant biosecurity systems. PHA achieves this by:

- Enhancing the commitment of governments and industries to work together.
- Enhancing the operation and integrity of Australia's plant pest emergency response arrangements.
- Assisting national management of biosecurity risks.
- Monitoring performance and promoting continual improvement of Australia's plant biosecurity system.
- Determining future needs of Australia's plant biosecurity system.
- Facilitating improved national investment in plant biosecurity.

CSIRO Biosecurity Flagship

During the development of this Strategy, CSIRO established a new Flagship as its contribution to the national Biosecurity R&D effort and as a clear sign of commitment to Biosecurity R&D. The Biosecurity Flagship will assemble strong multidisciplinary teams to tackle major national and international challenges across the spectrum of animal and plant industries, the environment and human health. Flagship research will address biosecurity problems and risks posed by serious pests, with a focus on exotic and emerging pests and some established where they directly compromised trade or human health.

PBCRC

The PBCRC was established in recognition of the need to strengthen the plant biosecurity scientific capacity of Australia. The PBCRC started its six year term on 1 July 2012, as an extension CRC from the Cooperative Research Centre for National Plant Biosecurity, which began operating in November 2005.

The PBCRC centrally coordinates plant biosecurity research across all Australian states and territories. The PBCRC has an extensive collaborative network of researchers and educators from 27 participating organisations from both Australia and overseas, representing industry, universities and state and federal governments.

The aim of the PBCRC is to develop and deploy scientific knowledge, tools, resources and capacity to safeguard Australia, its plant industries and regional communities from the economic, environmental and social consequences of damaging invasive pests. It does this by:

- undertaking world class collaborative research
- building biosecurity capacity through education and training
- enhancing awareness through national and international community engagement
- promoting community and enterprise development.

International biosecurity initiatives

The Strategy needs to address and balance pre-border, border and post-border biosecurity activities to protect against the priority biosecurity threats. There are many organisations involved in international development that have an interest in biosecurity. Their focus is primarily capacity building and while they

have an interest in research and postgraduate training, overall there is limited investment in and capacity for biosecurity RD&E by international organisations and Australia's near neighbours.

Priorities that have been identified for pre-border research include:

- Addressing regional biosecurity priorities and as a consequence, reducing risk to Australia.
- Foreseeing and predicting pests and high risk areas, particularly in relation to climate change and biodiversity.
- Developing partnerships with other national and international research funders and providers to leverage more cost effective research outcomes.

Primary Industries Committees

SCoPI is the peak government forum for consulting, coordinating and integrating government action on national primary industry issues such as biosecurity reform, promoting productivity and sustainability of our primary industries and strengthening Australia's long term food security. The membership of SCoPI includes ministers from the Australian Government, Australian state and territory governments, and the New Zealand Government, who are responsible for agriculture, food, fibre, forestry, fisheries and aquaculture industries, and rural adjustment policy.

SCoPI is supported by PISC, which comprises the heads of the Australian national, state and territory and New Zealand government departments concerned with agriculture, as well as representatives of the Bureau of Meteorology and CSIRO.

PISC is in turn supported by NBC. NBC is responsible for managing a national strategic approach to emerging and ongoing biosecurity policy issues across jurisdictions and sectors (primary production and the environment). It also monitors development and implementation of the IGAB. The committee provides strategic leadership for managing national approaches to emerging and ongoing biosecurity policy issues across jurisdictions and sectors. It has an overarching, cross-sectoral and collaborative approach to national biosecurity policy and considers environmental, animal and plant biosecurity issues with a view to resolution or providing advice to PISC/ National Resource Management Standing Committee and PIMC/ Natural Resources Management Ministerial Council.

NBC also provides leadership to a range of supporting sectoral committees, including PHC and AWC. The role of these peak plant biosecurity committees is to maintain or improve plant health in Australia in support of the economy, environment and community.

PHC provides strategic policy, technical and regulatory advice and national leadership on plant biosecurity matters and has responsibility for overseeing the implementation of the government aspects of the NPBS. Through its subcommittees, currently SPHDS, SNPHS, the Subcommittee for Domestic Quarantine and Market Access and the Subcommittee on National Forest Health, PHC also guides a range of organisations through the establishment of national standards and facilitates a consistent national approach to legislative outcomes and standards within the plant biosecurity sector.

The AWC provide policy advice on national weed issues and support the implementation of the Australian Weeds Strategy by facilitating and coordinating consistent national action on weed tasks. They encourage the incorporation of weed management as an integral component of natural resource management at national, state and regional levels and facilitate the delivery of weed initiatives within the national biosecurity framework. The AWC are implementing a communications strategy, for increasing the profile of weeds throughout the community, government and key stakeholders. They also encourage monitoring and evaluation of the national weed management effort. The AWC ensures an integrated and effective national approach to the prevention and management of weed problems by reporting to and advising NBC on these matters.

Other national RD&E priorities relevant to the Strategy

Four national programs are identified with RD&E priorities relevant to this Strategy. The Commonwealth Environment Research Facilities Program (now the National Environmental Research Program) priorities include *Threats and risks to our environment*, the National Research Priorities include *Safeguarding Australia - Protecting Australia from invasive diseases and pests*, the Australian Rural Research and Development priorities (last updated in 2007) identify biosecurity as one of five broad priorities, and generic cross-sectoral biosecurity RD&E priorities were developed by NBC (see 5.3.2, Table 2).

PISC RD&E Framework Sectoral Strategies

Innovation and RD&E are key drivers to improving productivity and competitiveness in the primary industries sector, and making best use of Australia's natural resources under a changing climate.

The National RD&E Framework aims to facilitate greater coordination among the different sectors—Australian Government, state and territory governments, CSIRO, RDCs, industry and universities—to better harmonise their roles in RD&E related to primary industries and assure that they work together effectively to maximise net benefits to Australia.

The National RD&E Framework supports a strong culture of collaboration and coordination between the bodies, strengthens national research capability to better address sector and cross sector issues and focuses RD&E resources so they are used more effectively, efficiently and collaboratively, thereby reducing capability gaps, fragmentation and unnecessary duplication in primary industries RD&E.

When the Framework is fully implemented, it is expected that research capability will become more collaborative, have larger critical mass, and will be less fragmented. Efficiency and effectiveness of RD&E will be markedly improved overall.

Agencies will retain and build capability in fields strategically important to their jurisdictions and industries. Over time, capability will be consolidated into stronger national centres or networks, and it will become more apparent where career prospects in a particular industry or field lie. Agencies may also withdraw capability in some areas not strategically relevant.

Productivity Commission review of rural RDCs (RRDCs)

The review of RRDCs undertaken by the Productivity Commission aimed to (amongst other terms of reference):

Examine the extent to which RDCs provide an appropriate balance between projects that provide benefits to specific industries versus broader public interests including examining interactions and potential overlaps across governments and programs, such as mitigating and adapting to climate change; managing the natural resource base; understanding and responding better to markets and consumers; food security, and managing biosecurity threats.

The review noted that the National and Rural R&D priorities included a focus on biosecurity in the form of *protecting Australia's community, primary industries and environment from biosecurity threats*. A number of organisations provided comment to the Commission that emphasised the need for further innovation in the government sector and the need to use funds for such an exercise. This was based on the need to use public funding to ensure that knowledge levels and expertise on biosecurity threats is kept up to date.

The review recommended the need for a new RRDC to deal with cross sectoral issues such as biosecurity, climate change, water, biodiversity, etc. However, the Australian Government has not instigated any actions relating to this recommendation.

Quarantine and Biosecurity (Beale) Review

The 2008 Beale Review of Australia's quarantine and biosecurity arrangements recommended improving partnerships between governments, industries and the community. The concept of partnerships has been in place for more than a decade as evidenced by Animal Health Australia's (AHA) establishment and the Nairn Report (*Australian Quarantine: a shared responsibility*) recommendations in the mid-1990s. The establishment of the IGAB[8] and reform of biosecurity legislation[9] are key post-Beale developments[10].

State government biosecurity strategies

State governments are implementing biosecurity strategies as part of significant change agendas involving new cross sector structures and partnerships for improving decision making and prioritising investments, building skills and capabilities, and strengthening biosecurity systems, policies and operations. Further details are provided in the Biosecurity Strategy for Victoria[11], Queensland Biosecurity Strategy 2009-2014[12], NSW Biosecurity Strategy[13], South Australia Biosecurity Strategy 2009-2014[14], Tasmanian Biosecurity Strategy[15] and from the Biosecurity Council of WA[16].

While the jurisdictional biosecurity strategies include biosecurity RD&E, they are limited by lack of operational resources. State government agriculture agencies are facing significant budget cuts in 2012 and 2013 of between 10 and 30 percent in real terms. The impact on biosecurity capabilities is yet to be determined, however it is fair to assume a government environment of decreasing resources for biosecurity in the short to medium term.

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[8] **www.coag.gov.au/node/47**

[9] **www.daff.gov.au/bsg/biosecurity-reform/new-biosecurity-legislation**

[10] An update on government actions in response to the Beale Review is available at **www.aph.gov.au/parliamentary_business/committees/senate_committees?url=rrat_ctte/quarantine_2010/report/c04.htm**

[11] **www.dpi.vic.gov.au/dpi/nrenfa.nsf/LinkView/A71D34F3B2253F88CA2575C1007DF6ED**

[12] **www.dpi.qld.gov.au/4790_12541.htm**

[13] **www.dpi.nsw.gov.au/biosecurity/nsw-strategy**

[14] **www.pir.sa.gov.au/pirsa/biosecurity/south_australias_biosecurity_strategy**

[15] **www.dpiw.tas.gov.au/inter.nsf/WebPages/CYAA-8Y48HJ?open**

[16] **www.biosecurity.wa.gov.au/**

Appendix 4. Major, Support and Link organisations for plant biosecurity RD&E

During the preparation of this Strategy one of the key components developed was a list of the Major, Support and Link organisations[17], which was developed against each of the commodity groups covered by this Strategy and also weeds (Table 1 below). This matrix has been considered and endorsed by all state and territory agencies. If an agency identifies itself as a Major, Support or Link partner it demonstrates a commitment by the agency to support the implementation of the strategies and action items identified in the Strategy. This demonstrates the complexity of stakeholders involved and the challenges to develop fully integrated plant health and biosecurity RD&E nationally.

[17] ***MAJOR*** – agency will take a lead national role by providing significant R&D effort
SUPPORT – agency will undertake R&D but no other agencies will provide the major effort
LINK – agency will undertake little or no R&D, instead it will access information and resources from other agencies.
Note: It is understood that organisations will be subject to budget fluctuations and will need to adjust their MAJOR, SUPPORT and LINK status over time in areas of specialisation. This Strategy provides a vehicle to stabilise core capability and to take a collaborative approach to managing risks arising from any changes in an organisation that are likely to influence future RD&E capacity.

Appendix 4 Table 1. Major Support and Link R&D organisations for each commodity covered by the Strategy.

Commodity groups	PB CRC	Qld	Vic	Tas	NT	SA	WA	NSW	CSIRO	Universities	PHA	Comm DoA
Crops **(Broad acre)** **e.g. grains, wheat, sorghum, sunflower**	Participants: GRDC, DAFWA QDAFF, PHA	Major QDAFF Ecosciences Precinct and Toowoomba	Major DEPI Vic AgriBio Grains Innovation Park Horsham			Major SARDI Plant Science Centre	Major DAFWA South Perth	Major NSW DPI Elizabeth Macarthur Agricultural Institute (EMAI)	Major Black Mountain (ACT) Ecosciences Precinct, Brisbane Floreat Park Perth	Major University of Sydney Murdoch University (State Agricultural Biotechnology Centre-SABC) La Trobe University (AgriBio) University of Adelaide (Waite) Curtin University	Link	Link
Horticulture **(Temperate)**	Participants: HAL, QDAFF, DEPI Vic, NSW DPI		Major DEPI Vic AgriBio	Support TIA		Support SARDI Plant Science Centre	Major DAFWA South Perth	Major NSW DPI EMAI		Major La Trobe University (AgriBio) Support Murdoch University University of Adelaide (Waite)	Link	Link
Horticulture **(Tropical)**	Participants: HAL, QDAFF, DEPI Vic, NSW DPI	Major QDAFF Ecosciences Precinct Cairns Laboratory			Support NT DPIF Berrimah Farm				Major Queensland Ecosciences Precinct			
Sugar		Major BSES (now SRA)					Link	Link			Link	Link

Commodity groups	PB CRC	Qld	Vic	Tas	NT	SA	WA	NSW	CSIRO	Universities	PHA	Comm DoA
Cotton		Support QDAFF Ecosciences Precinct					Link	Major Cotton Research Institute	Major Cotton Research Institute, Queensland Ecosciences Precinct	Support University of New England	Link	Link
Forestry		Support QDAFF Ecosciences Precinct		Link Forestry Tasmania			Link Forest Products Comm.	Major NSW DPI West Pennant Hills		Major Murdoch University Link University of Tasmania	Link	Link
Honey Bees						Support SARDI	Support DAFWA South Perth		Major	Support University of WA University of Sydney University of New England University of Adelaide (Waite)	Link	Link
Viticulture	Participant:Phylloxera Board of South Australia		Support DEPI Vic AgriBio	Link TIA		Major SARDI Plant Research Centre	Link			Major University of Adelaide (Waite) La Trobe University (AgriBio) Curtin University	Link	Link
Nursery and native plants							Link			Major Murdoch University	Link	Link

Commodity groups	PB CRC	Qld	Vic	Tas	NT	SA	WA	NSW	CSIRO	Universities	PHA	Comm DoA
Native plants							Link			Major Murdoch University Support University of Sydney University of Adelaide (Waite)	Link	Link
Floriculture							Link					
Pastures		Support QDAFF Ecosciences Precinct				Support SARDI Plant Research Centre	Link DAFWA South Perth	Support NSW DPI EMAI		Support University Tasmania University of Adelaide (Waite) Curtin University	Link	
Weeds		Major QDAFF Tropical Weeds Research Centre (Charters Towers and South Johnstone) and Ecosciences Precinct	Support DEPI Vic AgriBio	Support TIA		Major SARDI Plant Research Centre	Support DAFWA South Perth		Major Black Mountain (ACT) Ecosciences Precinct, Brisbane Perth Floreat Park	Support University of New England Charles Stuart University Southern Qld University University of WA University of Wollongong Curtin University Melbourne University University of Adelaide (Waite)	Link	Link

Commodity groups	PB CRC	Qld	Vic	Tas	NT	SA	WA	NSW	CSIRO	Universities	PHA	Comm DoA
Fresh water aquatic weed			Major DEPI Vic AgriBio							Support Murdoch University La Trobe University (AgriBio) Curtin University		
Cross sectoral			Support DEPI Vic AgriBio				Support DAFWA South Perth		Major	Support Queensland University of Technology Murdoch University La Trobe University (AgriBio)	Link	Link
Social sciences	Participants: Charles Darwin University, CSIRO						Support		Major Black Mountain (ACT) Brisbane Ecosciences Precinct Perth Floreat Park	Major Charles Darwin University Support University of New England	Link	Link

Appendix 5. Summary of the National Plant Biosecurity R&D Capability Audit Report

The following tables and figures support the text in Section 6.7. They have been extracted from the *Plant Biosecurity R&D Capability Audit* which is also available as an attachment to this Strategy on request to Plant Health Australia. The full audit can be found at **www.daff.gov.au/__data/assets/pdf_file/0006/2292414/Biosecurity_R,D_and_E_Capability_Audit.pdf**

The audit has some limitations (See 5.2 below) and specific interpretations of the data should be made with caution.

5.1 Background

The purpose of this audit was to inform the development of the National Biosecurity RD&E Framework (Schedule 8 of the IGAB) in addition to development of the National Plant Biosecurity RD&E Strategy under the National Primary Industries RD&E Framework.

The audit was conducted between January and July 2012 and provided a snapshot in time of biosecurity R&D capability across plant health and weeds. The data collected in the audit was also supplemented with data provided by National Plant Biosecurity Status Report.

Information on the human resources engaged in biosecurity R&D and the infrastructure available was collected, but information on staff engaged in delivery of routine services e.g. diagnostics was not. Extension activities were not captured. In addition a qualitative survey was conducted to garner information on gaps and future biosecurity R&D needs.

Table 1 shows key contributors. All state and territory governments responded except the ACT. Many universities did not contribute. Private R&D providers were not surveyed during the audit.

The data were analysed to identify areas of strength and weakness nationally with an eye to future capability requirements and succession planning.

Appendix 5 Table 1. Key contributors to the biosecurity capability audit

Organisation
Australian Government
CSIRO
DAFF
State and territory governments
New South Wales Department of Primary Industries (NSW DPI)
Northern Territory Department of Primary Industry and Fisheries (NT DPIF)
Primary Industries and Regions South Australian (including SARDI) (PIRSA)
Queensland Department of Agriculture, Fisheries and Forestry (QDAFF)
Tasmanian Department of Primary Industries, Parks, Water and the Environment (DPIPWE)

Organisation
Department of Environment and Primary Industries Victoria (DEPI Vic)
Department of Agriculture and Food Western Australian (DAFWA)
Universities
Curtin University
Central Queensland University[18]
University of New England
University of Technology, Sydney

5.2 Details of audit information

The audit collected information on human capability (e.g. full time equivalents (FTEss, researcher role, discipline, pest type, national biosecurity R&D priority area), levels and sources of external investment received by organisations for the year 2011 and infrastructure investments in plant biosecurity for the last 5 years (2007-2011).

Endemic, exotic and emerging pests were included in the scope of the audit. Generic/cross-sectoral R&D capabilities and specific biosecurity capabilities were captured.

Capability audit limitations

There were a number of recognised limitations to the audit and therefore data summaries should be interpreted with caution. Limitations include:

- Different interpretations of how to record FTEs despite detailed guidelines and hence organisations may have over or underestimated FTEs in biosecurity R&D.
- Different approaches and interpretations of scope and definitions of biosecurity R&D.
- Missing data.
- Exclusion of extension from the audit scope.
- Capability can be found in organisations that were not audited or did not provide a response to the audit, for example, environmental departments (state/territory and Australian Government), museums, botanic gardens, private research providers and universities.
- Human capability commonly extends across disciplines, species and/or pests and the audit may not have captured this as researchers could only identify one of each through the audit tool.
- The audit did not capture the entire capability available to be directed at biosecurity related outcomes (although not currently applied to biosecurity issues), rather it collected data only on current capability investment in biosecurity.

[18] Central Queensland University responded to the audit, however they did not have any capability in plant biosecurity R&D

5.3 Analysis of audit data

Human resources

A total of 498 FTEs conducted R&D in plant health (391), weeds (74) and in cross-sectoral activities (33). Of these 498 FTEs, 278 scientists (FTEs; see Table below) were supported by 210 technicians. Only 10 postgraduate students were identified.

Agency	DAFF	CSIRO	QLD	NSW	Vic	SA	WA	NT	TAS	Universities	Total
Total FTEs	23.5	36	67	36	60	17	8.5	2	0	28	**278**

External investment was substantial and exceeded $30m, for plant health $28m, for weeds $3m and $0.4m for cross-sectoral activities.

The number of FTEs and the amount of external investment was mapped against the national biosecurity R&D priorities and objectives. Cross sectoral activities have not been included in the following analysis as the majority of activity was directed at other sectors. The universities did not provide FTEs mapped against the priorities and are not included in the table. These priorities (see 5.3.2, Table 2) were developed by NBC and are cross-sectoral priorities (i.e. across animal health, plant health, weeds etc.).

Appendix 5 Table 2. Number of FTEs and amount of external funding mapped against the National Biosecurity RD&E priorities.

Priorities	Number FTEs	Amount external funding
1. Minimise the risk of entry, establishment, or spread of pests and diseases	175	$8.5m
2. Eradicate, control or mitigate the impact of established pests and diseases	236	$21.1m
3. Understand and quantify the impacts of pests and diseases*	14	$0.64m
4. Cost effectively demonstrate the absence of significant pests and diseases*	7	$0.22m
Total	**432**	**$30.5m**

* Under resourced, note data missing from some agencies.

The majority of external funding in plant health and all of the weed external investment was directed at outcome 2. This is not unexpected as industry is mostly focussed on control of endemic pests. Consequently the majority of FTEs were directed at outcome 2 as agencies traditionally co-invest with industry via the RIRCs. There is substantial under investment from external sources in outcomes 3 and 4 and relatively little activity, only 21 FTEs. Data was not collected on investment by R&D agencies.

Further analysis was done on each priority to elucidate more precisely what areas are under resourced. The results for priority 1 are presented in Table 3 below.

Appendix 5 Table 3. Number of FTEs and amount of external funding mapped against the National Biosecurity RD&E priority 1.

Priority 1. Minimise the risk of entry, establishment, or spread of pests and diseases.		
Objective	**Number FTEs**	**Amount external funding**
1A. Develop the knowledge base for assessing and managing the risk of new pests and diseases, invasion pathways, and the susceptibility of ecosystems to invasion, in a changing global climate.	63	$2.1m
1B. Enhance detection, surveillance and diagnostic systems.	37	$2.4m
1C. Understand the sociological factors associated with the adoption of risk mitigation measures by stakeholders*	5	$0m
1D. Develop knowledge and strategies to prevent and contain the spread of pests and diseases within national borders.	34	$1.8
1E. Develop tools and decision-making frameworks for prevention and eradication	36	$2.3m
Total	**175**	**$8.5m**

* Under resourced, note data missing from some agencies.

At first glance it appears that the R&D into risk assessment is well resourced, however of the 63 FTEs directed towards objective 1A, 37 are DAFF risk analysts whose work is mainly in conducting risk analysis rather than into R&D to improve risk analysis. Once technicians are removed from the data the number of FTEs in risk analysis drops to 12. This area may be considered at risk but numbers from ACERA were not captured by the audit.

The resources are spread fairly evenly between four of the objectives. The exception is 1C with few resources directed towards social research. Since this audit was conducted the PBCRC secured funding and has an entire program devoted to social research.

The results for priority 2 are presented in Table 4.

Appendix 5 Table 4. Number of FTEs and amount of external funding mapped against the National Biosecurity RD&E priority 2.

2. Eradicate, control or mitigate the impact of established pests and diseases		
Objective	**Number FTEs**	**Amount external funding**
2A. Characterise the movement of pests and diseases through complex environments*	19	$0.9m
2B. Develop effective and integrated approaches to managing established pests and diseases of national significance	128	$10.9m
2C. Understand risk factors that drive emergence of new pests and diseases*	20	$0.3m
2D. Understand the interaction of pests and diseases with the invaded system	69	$9m
Total	**236**	**$21.1m**

* Under resourced, note data missing from some agencies.

The major effort in plant health is directed towards the development of IPM strategies and attracts substantial external funding. The risk here is if the external funding dries up, capability is redirected elsewhere. This has already happened in the vegetable sector.

The focus on IPM programs is control of pests in the crop and little effort is directed towards how pests move through complex environments. Exceptions to this are the development of area wide management tools for insect pests.

Most effort is directed at here and now problems most likely driven by industry funding. New and emerging pests attract little attention probably due to the focus on current problems, this effort lacks a future focus.

The results for priority 3 are presented in Table 5.

Appendix 5 Table 5. Number of FTEs and amount of external funding mapped against the National Biosecurity RD&E priority 3.

3. Understand and quantify the impacts of pests and diseases		
Objective	**Number FTEs**	**Amount external funding**
3A. Improve understanding of the environmental, economic, and social aspects of pests and diseases and of management activities to control them*	9	$0.32m
3B. Develop the knowledge base and protocols for managing the invasion risks posed by one sector for others*	5	$0.32m
Total	**14**	**$0.64**

* Under resourced, note data missing from some agencies.

Very little activity is directed towards this priority. Of concern is the lack of analysis of the impacts of pests that is required for decision making on eradication and control programs.

Note that the CRC is currently investing in some economic analysis that is being conducted by the university sector.

The results for priority 4 are presented in Table 6 below.

Appendix 5 Table 6. Number of FTEs and amount of external funding mapped against the National Biosecurity RD&E priority 4.

4. Cost effectively demonstrate the absence of significant pests and diseases		
Objective	**Number FTEs**	**Amount external funding**
4A. Develop tools that can cost effectively demonstrate the absence of national priority pests and diseases.*	7	$0.22m

* Under resourced, note data missing from some agencies.

The data indicates that little work is being done to develop surveillance tools or to develop new statistical/modelling methods to demonstrate area freedom.

Note that the CRC is starting to invest in this area, e.g. the development of a female fruit fly trap, analysis of tools to underpin surveillance in the grains industry

The number of NBC objectives considered to be under resourced and the underpinning science capability is presented in Table 7.

Appendix 5 Table 7. NBC objectives considered to be under resourced.

Objective	Number FTEs	Amount external funding	Capability required
1C. Understand the sociological factors associated with the adoption of risk mitigation measures by stakeholders	5	$0m	Social science
2A. Characterise the movement of pests and diseases through complex environments	19	$0.9m	Ecology/epidemiology
2C. Understand risk factors that drive emergence of new pests and diseases	20*	$0.3m	Ecology/epidemiology
3A. Improve understanding of the environmental, economic, and social aspects of pests and diseases and of management activities to control them	9	$0.32m	Social science Economic modelling
3B. Develop the knowledge base and protocols for managing the invasion risks posed by one sector for others	5	$0.32m	Ecology/epidemiology Social science
4A. Develop tools that can cost effectively demonstrate the absence of national priority pests and diseases.	7	$0.22m	Ecology/epidemiology Biology

*The majority of these FTEs are DAFF risk analysts who do not undertake RD&E.

This analysis shows that capabilities in ecology, epidemiology and social science are required to deliver on these under resourced NBC objectives.

The following analysis of capability against disciplines may assist in identifying areas that are under resourced and require further investment.

Capability across disciplines.

The audit collected information on the numbers of FTEs in plant biosecurity by discipline. The information collected was very detailed and so in order to identify trends capabilities have been grouped into broader groupings. There were 207 scientists working on biosecurity related outcomes in plant health, weeds and in cross sectoral activities (Table 8).

Appendix 5 Table 8. Full time equivalent (FTE) staff in plant health by discipline

Agency	DAFF	CSIRO	QLD	NSW	Vic	SA	WA	NT	TAS	Universities	Total
Discipline											
Agronomy		0.1	4.5	3.5	0.2		0.7			1.1	**8.9**
Bacteriology*			0.9	0.9	2						**3.8**
Bee pathology*		0.6								1.1	**1.7**
Biocontrol/weed control				5.5	4	1.3					**10.8**
Diagnostics				0.1	5#		1.3				**6.4**
Disease and pest resistance		5.3#	2.1	2.4		2.3					**12.1**
Entomology		2.8	21.4#	9.6	12.1#	4.6	1.3	1.3			**50.3**
Ecology/ epidemiology	8.3	7.9	6.3	0.7	4	1.5	0.7			10.6#	**18.7**
Economics	7.8#	0.7								0.2	**8.7**
Mycology/plant pathology		4.4	20.9#	9.8	21.6#	5.1	2.1	0.7		11.4	**76**
Nematology		0.8	3.4#	0.4	1.3	1.5	0.3				**7.7**
Policy/social science*	2	0.7		0.5		0.8	1.8			0.5	**6.3**
Risk analysis	5.4	2.3		2.3	2						**12**
Systems biology		13.3#	1		1.6			0.4			**16.3**
Taxonomy*		0.1			1.3						**1.4**
Virology			2.9	0.8	4.8#	0.3	0.4				**9.1**
Total	**23.5**	**36.1**	**67.3**	**36.4**	**60**	**17.4**	**8.5**	**2.3**	**0**	**27.6**	**279.1**

Areas of national strength

* Disciplines at risk

The data have limitations, for example the omission of the risk researchers at at the Centre of Excellence for Biosecurity Risk Analysis (CEBRA) and the absence of any entomologists working on biosecurity R&D recorded by CSIRO but general trends are evident. More than 50 percent of the capability (Scientific and Technical) is provided by two agencies, Queensland and Victoria, this is expected, as they are the two major crop-producing states.

Four areas are considered to be at risk: bee pathology and taxonomy. These areas are critical to Australia's biosecurity given the importance of bees for pollination and of taxonomy as the science that underpins diagnostics. Taxonomy is especially threatened due to the ageing population of taxonomists across Australia and the difficulty in attracting funds to this area.

The capability in ecology/epidemiology is considered important for the delivery of the under resourced NBC outcomes (Table 7) and seems to be concentrated in the university sector, especially as data was gathered from only three universities. This may be of concern, as the universities have no expectation to deliver biosecurity outcomes, unlike state agencies that have a legislative requirement.

5.4 Infrastructure

Through the Capability Audit, state and territory departments of agriculture identified plant biosecurity infrastructure investments (Table 9) made in the past five years (2007 – 2011). Investments for the past five years totalled $615.6 million. The major investments included development of the EcoSciences Precinct[19] (Dutton Park, Brisbane) valued at $259.5 million, biosecurity upgrade of the Elizabeth Macarthur Agricultural Institute (EMAI) at Menangle, NSW, valued at $57 million and development of the Centre for AgriBioscience[20] (AgriBio), located at La Trobe University's Bundoora campus, valued at $288 million. Other significant investments included development of the Central Coast Primary Industries Centre in Gosford, NSW, valued at $8.5 million, a molecular diagnostics laboratory at the Waite Campus, SA, valued at $1.7 million and greenhouses at the Wagga Wagga Agricultural Institute valued at $900,000.

[19] Note that this infrastructure was a joint venture between the Queensland Government and CSIRO and is not solely utilised for biosecurity R&D purposes

[20] Note that this infrastructure was a joint venture between the Victorian Government and La Trobe University

Appendix 5 Table 9. Plant biosecurity infrastructure in Australia as identified by stakeholders.

State	Infrastructure	Who uses the infrastructure?	Key R&D activities
QLD	Ecosciences Precinct, Boggo Road, Brisbane	QDAFF, CSIRO	Horticulture, Crops, Forestry, Weeds
	Coopers Plains Food and Nutritional sciences	CSIRO	
	BSES (now SRA)		Sugar
	University of Southern Queensland		Weeds
NSW	Plant Breeding Institute	University of Sydney	Crops
	Elizabeth MacArthur Agriculture Institute	NSW DPI, PBCRC, University of Sydney, University of Wollongong	Crops, Horticulture, Pastures
	Grafton Primary Industries Institute	NSW DPI Southern Cross University QDAFF, Forest and Wood Products Australia CSIRO, University of New England	Crops, Weeds, Forestry
	Australian Cotton Research Institute	NSW DPI, CSIRO	Cotton
	Orange Agricultural Institute	NSW DPI	Weeds, Crops, Pastures
	Forest Science Centre	NSW DPI, University of Western Sydney, University of Technology Sydney, Charles Sturt University, CSIRO	Forestry
	Central Coast Primary Industries Centre		Floriculture
	Wagga Wagga Agriculture Institute	NSW DPI	Crops, Weeds, Viticulture Pastures, Horticulture
	Hawkesbury District Office	NSW DPI, University of Wollongong	Weeds

State	Infrastructure	Who uses the infrastructure?	Key R&D activities
	Tamworth Agricultural Institute	NSW DPI	Crops, Pastures, Weeds
	Yanco Agricultural Institute	NSW DPI	Horticulture
	University of New England		Cotton, Bees, Weeds
	Charles Sturt University		Weeds
	University of Wollongong		
	University of Sydney		Crops, Bees, Native Plants
Vic	AgriBio	DEPI Vic, La Trobe University	Horticulture, Viticulture Weeds, Fresh water aquatics
	University of Melbourne		Weeds
	DEPI Horsham	DEPI Vic	Crops
	DEPI Mildura	DEPI Vic	Crops, Horticulture
	DEPI Tatura	DEPI Vic	Horticulture, Crops
Tas	Forestry Tasmania		Forestry
	University of Tasmania		Forestry, Pastures
	Tasmania Institute of Agriculture	DPIPWE	Horticulture, Crops
SA	Waite Institute	SARDI	Crops, Horticulture, Viticulture, Pastures, Weeds
	University of Adelaide		
	Murray Lands - Loxton	PIRSA	Horticulture, Viticulture Crops
WA	DAFWA		Bees, Weeds, Horticulture, Grains
	University of Western Australia		Bees
	Curtin University		Weeds
	Murdoch University		Grains, Horticulture, Pastures, Native plants, Post-harvest
NT	Berrimah farm		Horticulture
ACT	Black mountain	CSIRO	Crops, Weeds

Appendix 6. Key definitions

Agribusiness: is a generic term for the various businesses involved in food production, including farming and contract farming, seed supply, agrichemicals, farm machinery, wholesale and distribution, processing, marketing and retail sales.

Biosecurity: The management of risks to the economy, the environment and the community (e.g. social amenity etc.), of pests entering, establishing and spreading within Australia.

Development: is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, or to substantially improve those that already exist. It is taken to include application, adaptation and validation of 'known' technologies to suit regional or local environments, varieties and practices. At one end it may overlap with applied research and at the other demonstration trials' — which verges upon extension.

Extension: is concerned with communication, information exchange and promotion of learning in order to build capability and change practice. It includes a wide range of communication and promotion tools and activities including the roles of direct advisory or consultancy services, field days and update events and electronic delivery mechanisms. Extension includes the development of practice change methodologies required to achieve high levels of adoption of research outcomes and new technologies. It is recognised that the tools and delivery mechanisms will, by nature, be diverse and vary according to the intended outcome sought, the target segment of the industry and the local situation.

Industry: for the purpose of the Strategy, 'industry' includes growers, input suppliers, providers of storage, handling and transport services, processors and exporters.

Major–support–link: these terms have a special meaning in the Strategy based on the definitions developed by the PISC R&D sub-committee for the role of agencies and jurisdictions under the National RD&E Framework.

1. **Major:** take a lead role by providing significant R&D effort by maintaining capability and leadership to deliver national R&D outcomes.
2. **Support:** contribute to R&D in partnership, but the major role is taken by another agency.
3. **Link:** undertake little or no R&D but access information and resources from other agencies and undertake extension activities only.

Pests: All invertebrate pests (insects, mites, snails and nematodes), pathogenic microbes (bacteria, fungi, fastidious prokaryotes and viruses) and pest plants (weeds) that are deleterious to plants, plant products or bees.

RD&E: the continuum that extends from research through experimental development to extension of the regionally-interpreted and validated research.

Research encompasses the following definitions adopted by the Productivity Commission (Productivity Commission 2007, Public Support for Science and Innovation, research report, Productivity Commission, Canberra):

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application of use in view. Basic research is sometimes divided into pure basic research and strategic basic research, with the latter directed at acquiring knowledge towards specified broad areas in the expectation of useful discoveries.

Applied research is also original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Sectoral: refers to the industry based RD&E strategies being developed under the PISC Framework.

Cross-sectoral: refers to the RD&E strategies being developed under the PISC framework which have relevance for more than one animal or plant primary industry sector, or for public health and the environment.

Supply chain: supply chains are the set of entities that link the flow of products, services, finances and information from a source to a customer.

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