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Biosecurity in Australia: An Assessment of the Current Funding Approach

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Abstract

Australian governments and industries have limited resources to tackle established pests and diseases and to prevent new incursions. As the biosecurity threats to Australia's economy, environment and society change, it is important that the funding and governance of responses are appropriately aligned and resourced. Key decisions concern which biosecurity threats will receive funding, how much funding they will receive, and who will be responsible for providing the funding. In this paper we review the current national approach to biosecurity funding, and a high level assessment is made against economic and public policy principles for allocation of resources to biosecurity. The review finds that the primary assessment for determining funding of national biosecurity response is benefit-cost analysis. However, benefit-cost analysis is often restricted to providing a net benefit of responding to one plant or animal pest or disease. The conclusion is that an approach which considers a portfolio of pests and diseases may be more appropriate in a limited resource environment.

Key words: biosecurity, funding, benefit cost analysis, public policy.

Introduction

Biosecurity may be defined as the actions undertaken by government, industry and the community to prevent, respond to and recover from pests and diseases that are a threat to a region's economy, environment and society. A well-functioning biosecurity system is vital for the maintenance of Australia's high biosecurity status, which in turn allows access to lucrative export markets for

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agricultural products. It also ensures that the entry and establishment of new pests and diseases will be minimised through the import process.

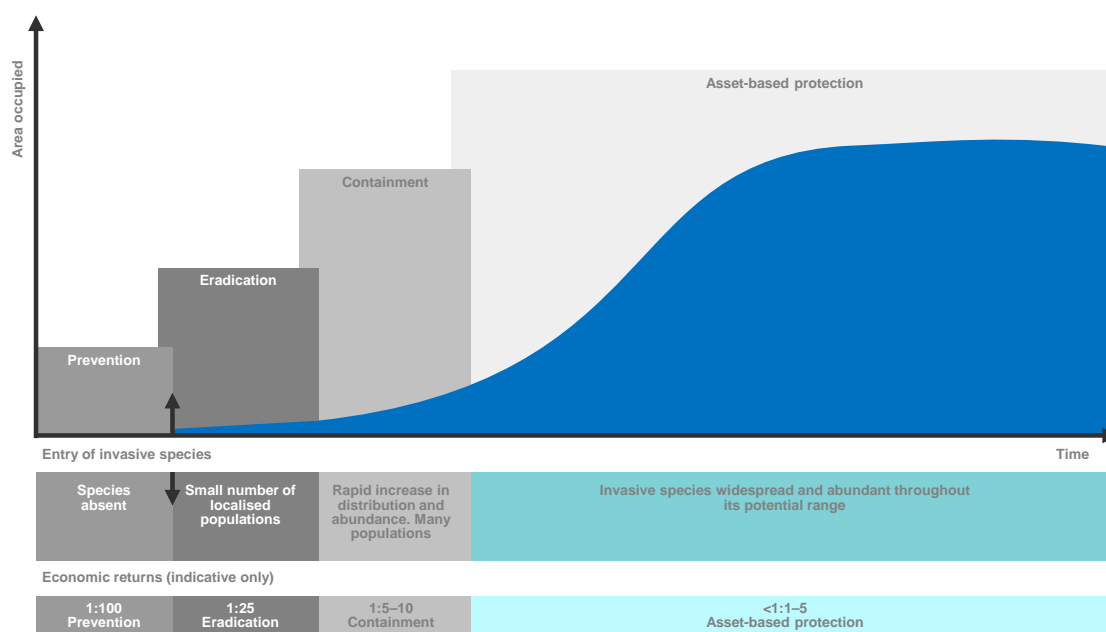
Australia's biosecurity legislative landscape has changed markedly in recent years. One of the major changes has been a move to a risk-based approach to regulation, in response to previous reviews of Australia's biosecurity system (e.g. Beale et al., 2008). The *Biosecurity Act 2015* – which replaced the century-old *Quarantine Act 1908* – came into operation in June 2016. During the course of the debate about the new legislation a number of Commonwealth and State inquiries were held into biosecurity matters (Brooks et al., 2015; Craik et al., 2016; Simpson and Srinivasan, 2014; Victorian Auditor-General's Office, 2015). A recent Productivity Commission report (2016) stated that Australia's biosecurity system will be most effective when resources are targeted to those areas of greatest return to the nation, from a risk management perspective, across the biosecurity continuum and across all pests and diseases.

The responsibility for maintaining Australia's high biosecurity status is shared between the federal government, state and territory governments and industry through various agreements and partnerships. This analysis explores the value of biosecurity; how biosecurity threats are changing; and the different responses to enact biosecurity. It reviews the allocation of biosecurity resources from an economic and public policy perspective and provides a high level assessment of Australia's national biosecurity arrangements.

The Biosecurity Challenge

The Australian Government spends more than \$600 million a year on activities related to managing biosecurity and imported food risk (Commonwealth of Australia, 2016). The operation of Australia's biosecurity system relies on cooperation between the federal, state and territory governments, importers, exporters and the wider community. The biosecurity system encompasses offshore risk-reduction activities; inspections of cargo, mail and passengers at the border; and post-border management of new and established pests and diseases. Australian governments and industry are

Figure 1: Generalised invasion curve (Source: Agriculture Victoria, 2015)



constantly managing risks from a large number of potentially damaging biosecurity threats (Craik et al., 2017). The challenge is to understand and prioritise the threats, and efficiently allocate limited funding across threats.

Potential responses to biosecurity risks may be categorised as either preventative or reactive. The generalised invasion curve sets out these different types of responses (Figure 1): prevention and preparedness; eradication; containment; and asset-based protection, and the indicative return on investment in each (Agriculture Victoria, 2015). Activities that lead to the prevention of new incursions provide the greatest return on investment, with those that are aimed at protecting assets from a widespread incursion provide the lowest return. The relationship between return on investment and the spread of pests over time has been widely examined in the literature (see for example Leung et al., 2002; Finnoff et al., 2010; Epanchin-Niell, 2017).

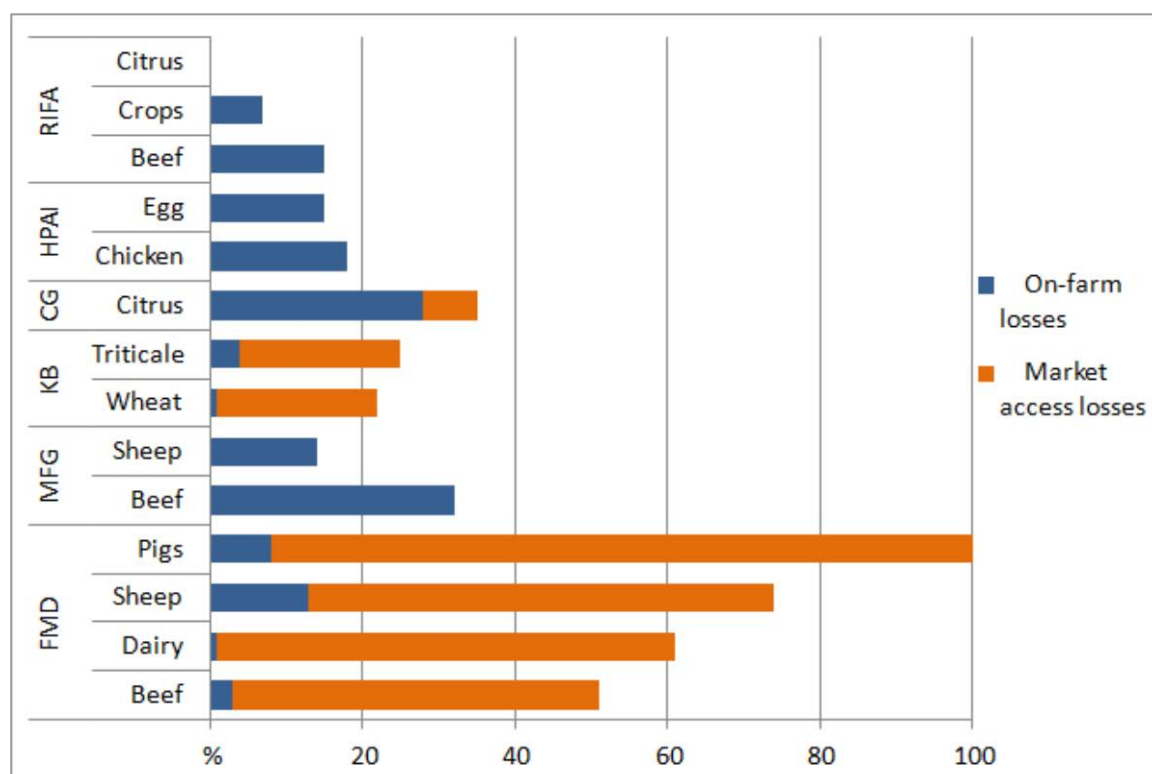
Where a new pest or disease is detected within Australia the response may be to eradicate, contain or do nothing, depending on the costs, benefits and risks associated with the pest and disease response (Hester et al., 2017). Once new pests and diseases establish within a country's borders, they are costly to manage. For example, it is estimated that an outbreak of virulent Newcastle disease in NSW between 1998 and 2000 cost \$50 million in direct losses (Nunn, 2011) and management of the red imported fire ant (RIFA) outbreak in Queensland has so far cost \$330 million (Wylie and Janssen-May, 2016), with another \$380 million committed over the next 10 years (Commonwealth of Australia, 2017). Analysis by the Productivity Commission (2003) found that in 2001 a single case of bovine spongiform encephalopathy (BSE or 'mad cow disease') would result in lost trade worth several million dollars a year; and this did not include social costs (such as suicide, long term health impacts), the impact on land values, and the effect on the viability of regional towns. Social impacts were included in the cost calculation of the 2001 foot and mouth disease (FMD) outbreak in the United Kingdom – the outbreak is estimated to have cost £8 billion (approximately \$13 billion at 2017 exchange rates) in lost revenue to the beef industry, control costs and other societal impacts (National Audit Office, 2002). See also the FMD analysis of Tozer and Marsh (2012).

Other examples of recent incursions include the Cucumber Green Mottle Mosaic Virus (CGMMV) a virus of melons, pumpkins, squash and cucumbers, detected in Queensland in 2017. When CGMMV was detected on watermelon farms in the Northern Territory in 2014, an eradication program led to destruction of crops and strict quarantine restrictions on the industry for almost two years (Prendergast, 2016). The recent emergence of Pacific Oyster Mortality Syndrome (POMS) led the industry to move to a POMS resistant native oyster. However, another pest – bonamia – has returned which is impacting on stock levels in Victoria's native oyster industry (Best, 2016).

The recently released final report of the independent review into the Intergovernmental Agreement on Biosecurity (Craik et al., 2017, 1) noted that Australia's biosecurity system "...underpins \$59 billion in agricultural production, \$45 billion of agricultural exports and our \$38 billion inbound tourism industry." Recent research reviewed by the Productivity Commission (2016) has demonstrated the value of this system to the Australian economy. For example, Hafi et al. (2015) investigated the benefits to Australian agriculture afforded by the biosecurity system. Six potentially significant biosecurity threats were used as case studies: FMD; Mexican feather grass; citrus greening; highly pathogenic avian influenza (HPAI); karnal bunt; and RIFA. The research measured the direct production losses, additional expenditure on control measures and damage mitigation, and export market losses that would result from establishment of each pest. For a typical broadacre farm, profits were found to be between \$12,000 and \$17,500 a year higher as a result of Australia's biosecurity system (Hafi et al., 2015) (Figure 2).

Australia's environment is also subject to biosecurity threats, in particular exotic weeds. Exotic weeds include Mexican feather grass, witchweed, Eurasian watermilfoil and fringed spider flower (DAWR, 2016). This may also include threats to the built environment such as damage to roads or railways (Heikkilä, 2011). Measures to prevent threats from exotic weeds includes assessment of risks with new imports and recognition programs.

Figure 2: Reduction in annual farm enterprise profits after an incursion (%)
(Source: Hafi et al., 2015)



Finally, many biosecurity threats can impact on human health and therefore it is important not only for agricultural production, but also Australia's population that biosecurity is managed. For example, Anthrax is an acute bacterial disease that causes three types of infection affecting the lungs, the digestive track or the skin. It can affect a wide range of domestic and wild animals as well as humans (DAWR, 2016). Bird flu is a highly contagious viral infection primarily in birds, and it has the capacity to infect humans (VAGO, 2015).

The changing nature of biosecurity concerns

The focus and effort of biosecurity response may change over time, as biosecurity risks change. Worldwide, biosecurity risks are changing because of a growth in both passenger and cargo movements between countries as well as changing climate, technology and community expectations (Lindner and McLeod, 2009; Nunn, 2011). Government responses to climate change will also impact on animal, health and environmental biosecurity risks (Nunn, 2011).

In 2014 the Commonwealth Scientific and Industrial Research Organisation (CSIRO) published a report considering Australia's future biological challenges (Simpson and Srinivasan, 2014). The report found that there are a number of megatrends that are placing pressure on Australia's biosecurity

Table 1: CSIRO Biosecurity Megatrends (Source: adapted from Simpson and Srinivasan (2014))

Megatrend	Description	Biosecurity implications
An appetite for change	<ul style="list-style-type: none"> Increased opportunity for Australian agriculture through growing global demand for food Agricultural pressures (e.g. water security, pesticide resistance) challenges productivity Greater intensification, vertical integration and expansion to remain competitive Growth in niche markets (e.g. organics, bio-products) 	<ul style="list-style-type: none"> Increasing importance of a pest and disease free status Focus on productivity improvements and international investment will impact on the strength of biosecurity system Intensification can create point sensitivities in the system Vertical integration required consideration of biosecurity across the value chain Agricultural expansion can impact on ecosystems New approaches may be required for niche markets
The urban mindset	<ul style="list-style-type: none"> Continued growth in urban populations Disconnect between metropolitan and regional areas Growing expectations for food production (e.g. organic, free-range, locally sourced) Cities encroachment of new areas of land A disconnect between peri-urban producers and others in agricultural network 	<ul style="list-style-type: none"> Increased disease risks from densely populated areas A lack of understanding of biosecurity issues from disconnected urban dwellers New and adaptive biosecurity requirements from changing consumer expectations Expansion of cities changing interactions between people, wildlife, agriculture and disease which can increase risks Engagement with peri-urban producers necessary to improve understanding and adoption of biosecurity practices
On the move	<ul style="list-style-type: none"> Increased international tourism Increased movement of goods and vessels around the world Increased risk of bioterrorism Increased movement of goods across interstate borders 	<ul style="list-style-type: none"> Increased opportunities for infectious diseases Increased risk of people and goods bringing pests and diseases into Australia A need for offshore biosecurity investment; need to balance biosecurity with protectionism Development of regional and global biosecurity standards Online retailing increases risks, ongoing vigilance needed for bioterrorism Need to focus on pests and diseases spreading over state borders
A diversity dilemma	<ul style="list-style-type: none"> Decreases in biodiversity with some species nearly extinct Human activity influencing biodiversity loss Increased efforts to preserve biodiversity Biodiversity impacted by a changing climate Loss of species and genetic diversity within agriculture 	<ul style="list-style-type: none"> Biodiversity loss can decrease resilience of our natural environments Increased need to manage invasive species. Increased need to understand the interconnections between biodiversity and biosecurity Risk that climate change moves pest and disease vectors into new areas Biodiversity and food security can be linked

The efficiency era	<ul style="list-style-type: none">• Ageing biodiversity specialists are not being replaced• Investment in biosecurity does not appear to be keeping pace with growing challenges• Future biosecurity challenges will need to involve increased use of technology and innovation• Importance of identifying barriers to efficient use of technological innovation	<ul style="list-style-type: none">• Australia's ability to respond to biosecurity threats is impacted by our lack of specialists• Increased opportunity from low cost sensors and automated systems to detect new pests• Improved decision making through data modelling and visualisation• Potential for increased information and engagement through new communication tools and behavioural and social sciences• Smaller, smarter and more capable diagnostic devices can create a step change in quarantine and surveillance activities• Poor design, lack of funding and poor data integration could limit the ability for tech. solutions.
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system and that it is crucial that Australia is able to respond appropriately. The CSIRO analysis considered five biosecurity megatrends and their key implications for Australia. The megatrends range from growing food demands and urbanisation of population to increased tourism and a focus on efficiency (Table 1). The report also suggests options for future management of biosecurity in Australia as a response.

The CSIRO report found that increasing agricultural production to meet global demand will lead to the intensification in many industries. This in turn will place more importance on Australia's pest- and disease-free status. The report also found that urban areas are continuing to encroach on agricultural land and as densely populated areas can incubate and exacerbate biosecurity risks, it is increasing important that these risks are managed. Australia is also becoming an increasingly popular destination for tourism which can create the opportunity for infectious diseases and illegal flora and fauna entering the country.

The Australian Government also recognises that expansion of agriculture in Northern Australia is likely to generate new biosecurity risks. The Northern Australia White Paper notes that the extensive coastline, sparse population and proximity to international neighbours increases the vulnerability to biosecurity threats. In fact, most of the Australia's biosecurity outbreaks over the past 10 years have occurred in northern Australia (Australian Government, 2015).

Concerns surrounding the ability of governments to respond adequately to new pest and disease incursions have recently been linked to (decreased) funding for biosecurity. The Victorian Auditor-General's Office (2015) undertook an audit into the effectiveness of biosecurity practices of livestock in Victoria including practices effecting exotic and other emergency livestock disease and the risk to primary production, animal welfare and human health. The report found that government surveillance of livestock disease had declined 39 per cent from 2011/12 to 2014/15. And between 2009/10 and 2014/15 core livestock biosecurity funding was reduced by 49 per cent. The audit found that a decline in financial and staff resources had reduced on-ground capacity for the Victorian Government to detect exotic outbreaks.

A report into the capability of Queensland biosecurity (Brooks et al., 2015) found concerns with Queensland's current ability to manage and respond to biosecurity threats. The report recommended a rebuilding of the agency responsible for leading biosecurity in Queensland to build capacity to respond to incursions and new operating models to prepare for future threats.

Allocating Limited Biosecurity Resources

As the biosecurity threats to Australia's agricultural industry, environment and human health change, it is important that the funding and the governance of the response is appropriately aligned and resourced. There is not only a need to ensure that biosecurity risks and potential consequences of incursions are minimised, but it is also important to recognise that additional costs posed by the biosecurity system may increase the cost of final goods for Australian and overseas consumers thus reducing competitiveness of these goods. Furthermore, government, industry and community resources available for biosecurity are limited, and therefore these resources must be allocated efficiently and effectively.

Key methodologies

One of the key challenges for government is to efficiently allocate limited biosecurity resources to manage the large number of pests and diseases that currently impact, or threaten to impact on the

Australian economy. Methods commonly employed to determine how resources should be allocated include benefit-cost analysis (Häsler and Howe, 2012; Sinden and Thampapillai, 1995), multi-criteria analysis (Kompas and Liu, 2013), cost effectiveness analysis (Heikkilä, 2011; Häsler and Howe, 2012), economic efficiency analysis (Smith and Webster, 2010) and portfolio theory (Akter et al., 2016).

Benefit-cost analysis (BCA) is the standard method for assessing the relative desirability of competing alternatives. It considers the direct and indirect costs and benefits of each alternative option and compares alternatives based on a net benefit, or a benefit-cost ratio (Sinden and Thampapillai, 1995).

This approach can consider the benefits and costs of actions as well as the probabilities of success (Harvey et al., 2010). Because some benefits and costs are difficult to value it is common for research in this area to be based on partial BCAs, where only the benefits and costs that can be easily valued are considered (Hester et al., 2013). Häsler and Howe (2012) considered the use of traditional BCA in evaluating the role of surveillance in national policies for Animal Health. Similarly, Harvey et al. (2010) used BCA in assessing Queensland Fruit Fly interventions.

Multi-criteria analysis is often seen as an alternative to BCA. BCA primarily considers efficiency, whereas multi-criteria analysis primarily considers effectiveness (Kompas and Liu, 2013). Where BCA tends to focus on an outcome – a net benefit or benefit cost ratio – a multi-criteria analysis focuses on the process that is used to obtain it. A multi-criteria analysis can also be used with quantitative or qualitative information. Kompas and Liu (2013) found that multi-criteria analysis was increasingly being used in biosecurity management. A multi-criteria analysis is sometimes considered to be more helpful when there are high levels of scientific uncertainty and it can allow stakeholders to interact to discuss uncertainty.

Smith and Webster (2010) use a decision tree approach, incorporating economic efficiency, in determining how decisions related to investment in biosecurity should be made. The decision tree is used to determine if a market failure exists, and subsequently, whether taxpayers or industry should therefore pay for the intervention. Next, an appropriate level of cost recovery for intervention is determined, and finally the cost recovery mechanism is determined. The decision would include a BCA to determine whether to proceed with suggested actions.

While BCA, multi-criteria analysis and decision tree approaches may be appropriate when considering investment in one project or policy problem, in the case of biosecurity, it may not result in the optimal allocation of resources across a number of interventions. Akter et al. (2016) have considered the application of portfolio theory to asset-based biosecurity decisions. The benefit of portfolio theory is that it firstly helps to allocate scarce resources across multiple pests and diseases, and secondly, it takes into account uncertainty. Allocation of resources to areas which will have the highest return is the primary premise of the portfolio rule. The portfolio rule assumes a certain budget and provides a structured method to the allocation of this budget to the various pests and diseases impacting on biosecurity (Kompas et al., 2016).

The method will allocate resources to those activities that have the highest returns (that is, the change in benefits over the change in costs) rather than using a simple benefit-cost ratio – the overall benefit-cost ratio will be maximised. Sensitivity testing allows for uncertainties in measuring benefits and costs. The portfolio method will take into account all costs (e.g. additional quarantine expenditure) and define the benefits (e.g. avoided costs due to losses to plant and animal health, environmental and social costs).

The portfolio approach allows multiple biosecurity responses to be assessed simultaneously. For example, as shown in Table 2, different patterns of expenditure across different types of responses could result in a significant increase in the overall return on investment.

A more traditional economic approach to determine the optimal management strategy is to undertake cost effectiveness analysis which can account for multiple factors such as ease of implementation, allocation of costs and benefits, the benefit-cost ratio and the attributable costs (Heikkilä, 2011).

Table 2: Example portfolio problem (Source: Kompas et al., 2016)

Portfolio	Initial allocation		Optimal allocation	
	Share (%)	Average benefit/cost	Share (%)	Average benefit/cost
1. Prevention	10	150.55	30	83.03
2. Surveillance	10	123.78	30	72.20
3. Eradication/ containment	10	70.15	20	64.57
4. Management (specific)	10	52.14	15	60.97
5. Management (other)	60	5.87	5	50.03
Overall		43.18		71.13

Principles for cost-sharing

There are many ways in which funds can be collected to achieve biosecurity outcomes. In determining who should pay and how much should be paid, a number of principles may be drawn upon. For example, in designing taxation principles the Henry Taxation Review (Commonwealth of Australia, 2008) assessed funding arrangements against beneficiary-pays funding; economic efficiency; horizontal equity; and simplicity, transparency, administration and compliance costs (Table 3).

Table 3: Henry Taxation Principles (Source: Commonwealth of Australia, 2008)

Principle	Description
Beneficiary-pays funding	Contributions from levy-payers should be in proportion to benefits received from the spending funded by the levy
Economic efficiency	In the absence of an identified market failure, levies should minimise distortions to market activity
Horizontal equity	Levy-payers in similar situations should be treated equally
Simplicity, transparency, administration and compliance costs	Levies should be simple and low-cost to administer and comply with Structural features of the system should be durable in a changing policy context, yet flexible enough to allow governments to respond as required

Similarly, the Organisation for Economic Co-operation and Development (OECD) developed fundamental principles of taxation (Table 4).

Biosecurity legislation adopted in Queensland in 2016 has been based on three foundational concepts – shared responsibility, risk-based decision making and the precautionary principle (Table 5).

Inconsistent funding arrangements add complexity to the management of biosecurity and mean that biosecurity risks may be funded out of priority order, or not funded appropriately. Similarly, the difficulty in determining who should pay is often complicated by who receives the benefits. For example, the diversity of industries who potentially benefit from the eradication of major pests make it difficult to determine cost contributions, while spillover impacts and free-riding of expenditure make it difficult to design policy responses and cooperative arrangements (Cook et al., 2013; Shortle, 2007; Hennessy, 2007; Wang and Hennessy, 2015).

Table 4: OECD Fundamental Principles of Taxation (Source: OECD, 2014)

Principle	Description
Neutrality	Levies should seek to be neutral and equitable between forms of business activities. A neutral levy will contribute to efficiency by ensuring that optimal allocation of the means of production is achieved
Efficiency	Compliance costs to business and administration costs for governments should be minimised as far as possible
Certainty and simplicity	Levy rules should be clear and simple to understand, so that taxpayers know where they stand. A simple levy mechanism makes it easier for individuals and businesses to understand their obligations and entitlements
Effectiveness and fairness	Levies should produce the right amount of tax at the right time, while avoiding both double taxation and unintentional non-taxation. In addition, the potential for evasion and avoidance should be minimised
Flexibility	Levy systems should be flexible and dynamic enough to ensure they keep pace with technological and commercial developments. It is important that a levy system is dynamic and flexible enough to meet the current revenue needs of governments while adapting to changing needs on an ongoing basis

Table 5: Foundational Principles of Queensland Biosecurity Legislation (Source: Brooks et al., 2015)

Principle	Description
Shared responsibility	All parties should bear a proportionate share of responsibility for the mitigation of biosecurity risks and share the cost of biosecurity responses
Risk-based decision making	Consider the likelihood and consequence of biosecurity risks in an uncertain environment and ensure appropriate and proportionate action
Precautionary principle	Mitigation control action to be manage biosecurity incursions in advance of scientific certainty, where unacceptable damage is likely

Each of the funding models discussed above attempts to appropriately share the costs of a response based on principles such as beneficiary pays and economic efficiency. The OECD and Henry Taxation Principles also note the importance of simplicity and transparency. The Queensland biosecurity-specific principles note the importance of ensuring that risks are appropriately addressed, and that caution is taken where there is an uncertain environment.

Understanding Australia's Current Biosecurity Arrangements

The Commonwealth Department of Agriculture and Water Resources (DAWR) is primarily responsible for pre-border and border activities; Commonwealth, state and territory governments and industries work together on post-border biosecurity responses. A summary of the types of responses in each of these three components is set out in Table 6.

While the Commonwealth, State and Territory governments each have their own governance and funding arrangements related to biosecurity (see for example Agriculture Victoria, 2015; NSW Department of Primary Industry, 2016), the following discussion focuses on the arrangements between the federal, state and territory governments of Australia.

The Intergovernmental Agreement on Biosecurity (IGAB)

At the national level an agreement to strengthen the national biosecurity status between the Commonwealth, state and territory governments (with the exception of Tasmania) came into effect in January 2012 – the Intergovernmental Agreement on Biosecurity (IGAB). The IGAB recognises the complexity of managing biosecurity and also notes that it will become increasingly challenging because of a changing climate, globalisation and population spread (Council of Australian Governments (COAG), 2012).

The IGAB has three objectives: (1) reducing the likelihood of exotic pests and diseases entering, becoming established or spreading in Australia; (2) preparing and allowing effective management and response to exotic and emerging pests and diseases; and (3) ensuring that significant pests and diseases already present in Australia are contained, suppressed or managed (COAG, 2012).

The IGAB recognises that many pests and diseases are a national issue, and therefore aims to create a coordinated approach to their management. The IGAB aims to ensure consistent and complementary systems are in place to maximise efficiency and effectiveness. The foundation for the operating model which underpins Commonwealth, state and territory governments' agreement is the Appropriate Level of Protection (ALOP). The ALOP is a high level of protection aimed at reducing biosecurity risks to a very low level, but not to zero.

The IGAB is administered through Commonwealth, state and territory ministers responsible for biosecurity matters. The IGAB establishes a National Biosecurity Committee (NBC) that is "responsible for managing a national, strategic approach to biosecurity threats and the impact of these on agricultural production, the environment, community wellbeing and social amenity" (Craik et al., 2016, 12). The National Biosecurity Committee sets out Action Plans to identify areas of national priority, and a Work Plan for implementing action plans is led by a lead jurisdiction for the particular matter. An Annual Report of implementation activities is developed each year.

The National Biosecurity Committee is supported by a number of sectoral committees for animal health, invasive plants and animals, marine pests and plant health as well as specialist expert groups and task-specific groups where required. The National Biosecurity Committee advises the Agriculture

Senior Officials Committee (AGSOC) and the Agriculture Ministers' Forum (AGMIN). This structure is set out in Figure 3.

Animal Health Australia (AHA) and Plant Health Australia (PHA) are examples of government-industry partnerships that have been set up to facilitate a national approach to animal and plant biosecurity. AHA and PHA aim to improve biosecurity outcomes by:

- conducting preparedness activities for emergency plant pest and animal disease,
- developing biosecurity manuals for specific industries and promoting on-farm biosecurity,
- implementing formal emergency preparedness, and
- upholding active communication between industry and governments (Craig et al, 2016).

The IGAB has a number of principles that underpin the biosecurity response:

- i) Biosecurity is a shared-responsibility between all governments, industry, natural resource managers, custodians or users, and the community,
- ii) In practical terms, zero biosecurity risk is unattainable,
- iii) The pre-border, border and post-border elements of the biosecurity continuum are managed to minimise the likelihood of biosecurity incidents and mitigate their impacts,
- iv) The biosecurity continuum is managed through a nationally integrated system that recognises and defines the roles and responsibilities of all sectors and sets out cooperative activities,
- v) Activity is undertaken and investment is allocated according to a cost-effective, science-based and risk-management approach, prioritising the allocation of resources to the areas of greatest return,
- vi) Relevant parties contribute to the cost of biosecurity activities:
 - a. Risk creators and beneficiaries contribute to the cost of risk management measures in proportion to the risks created and/or benefits gained (subject to the efficiency of doing so); and
 - b. Governments contribute to the cost of risk management measures in proportion to the public good accruing from them,
- vii) Governments, industry, and other relevant parties are involved in decision-making, according to their roles, responsibilities and contributions, and
- viii) Australia's biosecurity arrangements comply with its international rights and obligations (IGAB, 2012, 4).

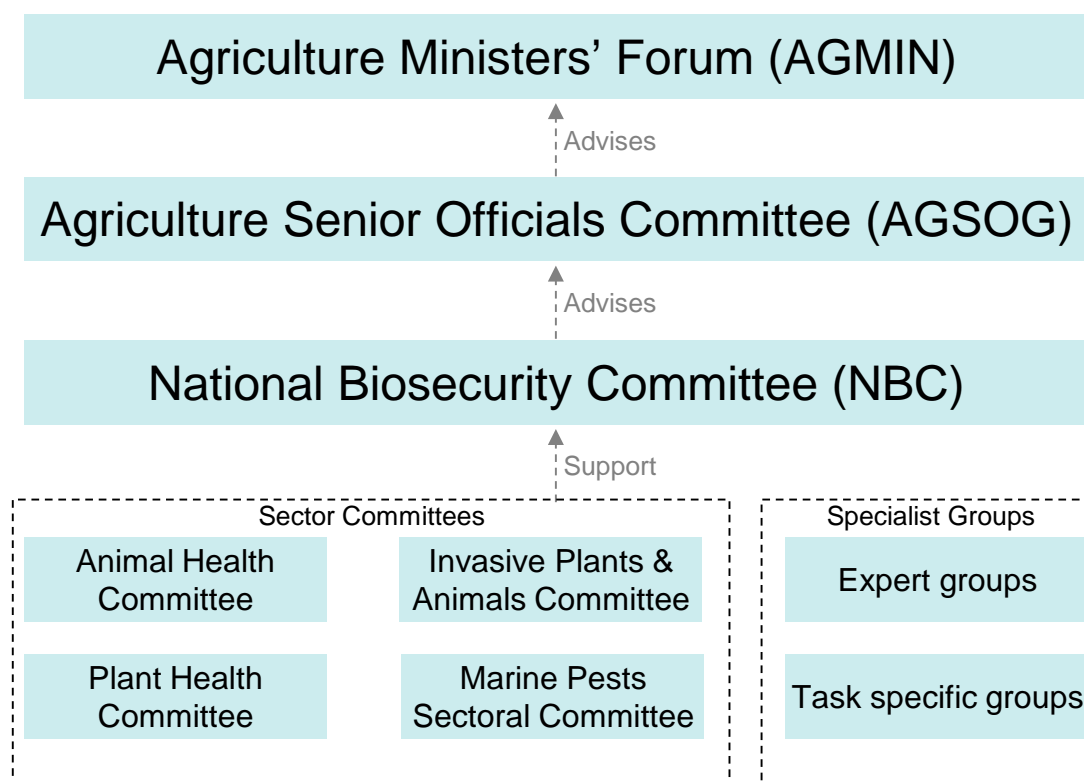
These principles lead to the conclusion that funding of biosecurity at an intergovernmental level should be underpinned by allocating funding to activities based on a cost-effective, science-based and risk-management approach. It also clearly articulates that biosecurity cost should be paid by those who created the biosecurity risks or gain the benefits from the biosecurity risks.

Industry approaches to pests and disease management

Plant industries involved in horticulture, cropping and forestry are threatened by more than 400 exotic plant pests. Examples include Asian citrus psyllid, exotic fruit flies, sugarcane stem borers, khapra beetle and tramp ants. The control of pests and diseases in the plant industries sector includes excluding some fresh produce from 'pest-free areas'; controlling pests in backyard fruit trees and reporting suspected exotic pests, weeds or diseases (DAWR, 2016).

Table 6: Potential responses to biosecurity (Source: Adapted from Plant Health Australia, 2016a; Craik et al., 2016, 2017)

	Pre-border	At the border	Post-border
Responsibility	Commonwealth Department of Agriculture and Water Resources	Commonwealth Department of Agriculture and Water Resources	Commonwealth, state and territory departments, and industry (Community also plays a role in alerting authorities to risks)
Purpose	<ul style="list-style-type: none"> Reduce the biosecurity risks associated with imported goods and manage the risks offshore 	<ul style="list-style-type: none"> Seek to verify imports meet biosecurity conditions Intercept biosecurity risks in live animals, plants, cargo, mail and with passengers 	<ul style="list-style-type: none"> Reduce the likelihood of a pest or disease establishing presence in Australia Minimise the potential impact
Activities	<ul style="list-style-type: none"> Risk analysis and import approvals (including import risk analysis & policy, risk management & communication) Export market access negotiations Offshore assessment, audit and verification International standards development Capacity building in overseas countries Gathering global pest intelligence 	<ul style="list-style-type: none"> Implementation of risk management system Policy implementation Education & awareness Inspection & monitoring Enforcement & compliance 	<ul style="list-style-type: none"> Emergency preparedness Practice & simulations Education & awareness Monitoring & surveillance National coordination & response to pest incursions Domestic quarantine Pest management Pre-emptive breeding

Figure 3: Structure of IGAB committees (Source: Adapted from Craik et al., 2016, 2017)

Cost-sharing under the National Environmental Biosecurity Response Agreement

As set out above, the primary allocation of funding is established through the IGAB. The first outcome of the IGAB was the development of the National Environmental Biosecurity Response Agreement (NEBRA). The NEBRA sets out the process for responding to biosecurity incidents that are in the national interest. The national approach to an outbreak of a pest or disease is a 10-step model to determine whether it is of national significance and who should pay. Step 9 of this process includes the determination of “whether it is technically feasible and cost beneficial to mount a national biosecurity incident response” (COAG, 2012)¹. The economic framework for determining investment in the NEBRA is through a BCA.

In determining the cost sharing arrangements for emergency outbreaks (Table 7), the NEBRA sets out that Commonwealth will share 50 per cent of eligible costs, and the remaining 50 per cent will be shared between states and territories in accordance with the following formula:

$$\text{A State/Territory Party's share of the combined investment} = \frac{\text{the number of people in a potentially affected area in that jurisdiction}}{\text{the total number of people potentially affected in Australia}}$$

The NEBRA sets out the national arrangements for responding to biosecurity incidents where there

¹ An independent review of the NEBRA was undertaken in 2017. The Final Report has been provided to the NBC for consideration (see www.agriculture.gov.au/biosecurity/emergency/nebra).

Table 7: Cost sharing under the Emergency Animal Disease Response Agreement and the Emergency Plant Pest Response Agreement (Source: adapted from AHA, 2016 and PHA, 2016b)

Category	Example of animal diseases	Example of plant diseases	Government funding	Industry Funding
1 – diseases that predominately impact on human health and/or environment	<ul style="list-style-type: none"> • Australian bat lyssavirus • Japanese encephalitis • Nipah virus • Rabies • Western, Eastern and Venezuelan equine encephalomyelitis 	<ul style="list-style-type: none"> • Dutch elm disease • Sudden oak death • Myrtle rust 	100%	0%
2 – diseases that have potential to cause major socio-economic consequences in domestic and international markets and also have significant impact on health and/or environment	<ul style="list-style-type: none"> • Avian influenza (highly pathogenic; virus subtypes H5 and H7) • Bovine spongiform encephalopathy • Brucellosis (due to <i>Brucella abortus</i>) • Brucellosis (due to <i>Brucella melitensis</i>) • Foot-and-mouth disease • Hendra virus 	<ul style="list-style-type: none"> • Oriental fruit fly • Papaya fruit fly • Philippine fruit fly • Karnal bunt • Citrus canker 	80%	20%
3 – diseases that have potential to cause major socio-economic consequences in domestic and international markets but minimal impact on health and/or environment	<ul style="list-style-type: none"> • African horse sickness • African swine fever • Anthrax (major outbreaks) • Avian influenza (highly pathogenic; other than subtypes H5 and H7) • Avian influenza (low pathogenic; virus subtypes H5 and H7) • Bluetongue • Classical swine fever • Contagious bovine pleuropneumonia • Encephalitides (tick-borne) 	<ul style="list-style-type: none"> • Sugarcane whitefly • Navel orangeworm • Hazelnut blight • Strawberry bud weevil • Boll weevil • Tomato/potato psyllid • Grapevine leaf rust • White leaf • Bacterial blight 	50%	50%
4 – diseases that mainly result in production loss	<ul style="list-style-type: none"> • Aujeszky's disease • Borna disease • Equine encephalosis • Equine influenza • Haemorrhagic septicaemia • Nairobi sheep disease • Transmissible gastroenteritis 	<ul style="list-style-type: none"> • Strawberry tortrix • Banana skipper butterfly • Asparagus rust • Spider mite • Wheat spindle streak mosaic virus 	20%	80%

are predominately public benefits (COAG, 2012). It recognises the public good component in responding to emergencies that primarily impact on the environment and/or social amenity. While the NEBRA emergency response activities are funded 50 per cent by the Commonwealth and 50 per cent between affected states and territories, where there is a pre-existing cost-sharing arrangements, and it is appropriate, negotiations with industry to contribute to responses will be considered. In determining if there should be private contributions, the NEBRA will consider if the payment mechanism is practical, equitable, non-distortionary and efficient.

A cost-shared response will only be undertaken under the NEBRA if meets the test of a *National biosecurity incident response* plan including a technical feasibility and benefit-cost analysis. The project must yield a net benefit as guided by the *National Framework for Biosecurity Benefit:Cost Analysis*. While this framework provides the basis for a comprehensive economic analysis and risk assessment to be undertaken, it necessarily is a single analysis on the efficiency of potential biosecurity management and control activities in response to a specific threat.

Similarly, when determining a response under the Emergency Animal Disease Response Agreement (EADRA) and the Emergency Plant Pest Response Deed (EPPRD), a response plan should include the technical feasibility of eradication of a suspected plant or animal pest or disease with at least a preliminary BCA of eradication of the pest or disease (DLA Piper, 2016; AHA, 2016).

As previously discussed, the primary tool for economic analysis of determining whether a response should go ahead under the national agreement is a BCA. In determining the funding mix, the IGAB itself has investment principles that aim to ensure the success of the biosecurity system through sustained investment over time (Table 8).

These funding principles broadly follow those set out by the Henry Taxation Review, the OECD and the Queensland legislation. All principles note that those who benefit should pay for the costs and that the benefits should exceed the costs. While the IGAB principles do not specifically point to flexibility, transparency and certainty, it should be inherent in the process for determining the sharing of costs required for a national biosecurity response.

Table 8: IGAB Investment Principles (Source: Adapted from COAG, 2012)

Principle	Description
Cost-effective, science-based and risk managed	Activity is undertaken and investment is allocated according to a cost-effective, science-based and risk-management approach, prioritising the allocation of resources to the areas of greatest return
Relevant parties contribute to costs	Relevant parties contribute to the cost of biosecurity activities: <ol style="list-style-type: none"> Risk creators and risk beneficiaries contribute to the cost of risk management measures in proportion to the risks created and/or benefits gained (subject to the efficiency of doing so), and Governments contribute to the cost of risk management measures in proportion to the public good accruing from them.
Involvement reflects public good accrued to each government	Governments, industry and other relevant parties are involved in decision making, according to their roles, responsibilities and contributions.

Assessment of the Current Biosecurity Framework

Government's role in biosecurity is clearly justified through both public good properties and externalities (Productivity Commission, 2016) – if provision of a pest- and disease-free environment was left to the private sector, less biosecurity services would be provided compared to what would be considered optimal from society's point of view.

Management of a number of pests and diseases requires a coordinated approach across a number of sectors and entities. The Commonwealth Government's involvement at a national level is important to enable international negotiations, trade, managing of conditions of entry into Australia and coordination of post-border responses.

The practical application of the principles outlined above, both in terms of a framework to determine whether funding should be applied as well as how funding should be allocated, is demonstrated in a case study of the national response to fruit flies.

Case Study – A plan for national coordination of fruit fly management

In March 2008 a Draft National Fruit Fly Strategy was released. The Strategy aims to develop a nationally coordinated approach to fruit fly management, that is viable, cost effective and sustainable (PHA, 2008). In April 2010 after two years of discussion a National Fruit Fly Strategy Implementation Action Plan was developed (PHA, 2010). The implementation of the Action Plan was led by an independent expert National Fruit Fly Strategy Implementation Committee that set out 15 broad initiatives and a national structure to govern the implementation of the initiatives.

A BCA of the National Fruit Fly Action Plan found that, under a 'low benefits scenario', actions under the plan would bring a net present value of benefits valued at \$286 million over 20 years with a benefit-cost ratio of 12.1:1 (Abdalla et al., 2012). The analysis found that the majority of these benefits would be borne by industry (under the low scenario):

- \$227 million of benefits (79 per cent) would be received by fruit fly susceptible industries through avoided production losses, savings in pre- and post-harvest treatment and increases in export value through improved market access,
- \$43 million of benefits (15 per cent) would be received by state and territory governments through reduced operational costs of maintaining pest-free areas, reduced costs for emergency response and management, and more cost-effective R&D, and
- \$16 million of benefits (6 per cent) would be received by the Australian Government through reduced costs for emergency response and management, and more cost-effective R&D.

In the 2015 Annual Report for Plant Health Australia it was noted that funding has been secured from government and Horticulture Innovation Australia Limited to implement the 15 broad initiatives in the Implementation Action Plan (PHA, 2015). While revenue sources are not specified in detail, the Report suggests at least 38 per cent of funding is from government sources (HIAL, 2015), despite only 21 per cent of the benefits being received by government. One could conclude that the initiatives in the fruit fly action plan are not aligned with principles that relevant parties contribute to costs in proportion to benefits received.

Discussion

The Commonwealth Government uses BCA to guide investment in biosecurity responses under the NEBRA. Use of a BCA can cause problems when viewed in isolation. Kompas (2016) contends that

while one biosecurity measure may provide a net benefit, it may not be the best use of resources. A portfolio approach that considers both a number of measures to address one threat, as well as measures that address different threats, will yield higher returns for limited biosecurity resources. It can also address uncertainty in allocation of resources. While a portfolio approach may be the best way to ensure that limited resources are allocated efficiently, the significant number of biosecurity threats, responses and limited data can limit their practical use (Heikkila, 2011).

While the economic framework to consider the investment in biosecurity responses in Australia may need to be expanded so that different pests and diseases with different risks and importance can be assessed against each other, the current cost-allocation principles for national plant and animal health responses also need to be considered further. As shown by the fruit fly case study, while the majority of benefits accrue to industry, the cost of the Action Plan is being borne by governments of Australia. Furthermore, Smith and Webster (2010, 1) noted that the industry-government sharing ratios were “far from ideal” in terms of allocative efficiency. They note that there is no ‘100 per cent industry pays’ category in deeds agreed between industry and government.

One of the reasons for government involvement at a level greater than what would be implied by benefit shares may be because of what Griffith et al. (2015) call “chain failure”. This occurs due to the suboptimal provision of “chain goods”, things like classification, grading, certification and inspection systems. For threats in categories 3 and 4 in Table 7, where industry is likely to accrue most of the benefits, high transaction costs in agricultural value chains often mean that appropriate processes and systems, such as biosecurity inspection, are not invested in by value chain partners, so all of the potential benefits may not be realised, and therefore, socially valuable biosecurity projects may not be carried out. Often government intervenes to ensure that transaction costs are lowered and a socially optimum amount is funded. For threats in categories 1 and 2 in Table 7, the case for government intervention is strongest but the difficulty in calculating social benefits can also lead to errors in public funding.

Finally, one of the key principles of the IGAB is that those responsible for creating the biosecurity risk should contribute to the cost of risk-management measures. Given that the main driver for the increasing spread of pests and disease across the globe is international trade, there is a real need to consider policy changes that force importers who inadvertently introduce new pests and diseases, to pay for clean-up costs (Waage and Mumford, 2008). Currently there is no regulatory imperative for importers to play any role in the management of diseases they might introduce.

Conclusion

The benefits of a well-functioning biosecurity system to the Australian economy, environment and way of life are widely acknowledged. This analysis suggests, however that the current approach to both allocation of resources within the biosecurity system, and cost-sharing arrangements at a Commonwealth Government level could be improved, to ensure that there is an efficient and effective response to future biosecurity concerns. It is therefore concluded that further consideration be given to the following two suggestions: first, ensure that the biosecurity response is coordinated to ensure maximum efficiency of use of resources. This may require the adoption of mechanisms to compare multiple responses at once, such as portfolio analysis, rather than benefit-cost analysis which assesses each response individually, and second, ensure that costs are appropriately allocated to those who benefit from the response.

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