Australian Government
Department of Agriculture, Fisheries and Forestry
ABARES

Benefit–cost analysis of the National Fruit Fly Strategy Action Plan

Ali Abdalla, Nicola Millist, Benjamin Buetre and Bruce Bowen

Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

Report to client prepared for Plant Health Australia
December 2012

This publication (and any material sourced from it) should be attributed as: Abdalla, A, Millist, N, Buetre, B & Bowen, B 2012, *Benefit–cost analysis of the National Fruit Fly Strategy Action Plan*, ABARES report to client prepared for Plant Health Australia, Canberra, December, CC BY 3.0.

Cataloguing data
Abdalla, A, Millist, N, Buetre, B & Bowen, B 2012, *Benefit–cost analysis of the National Fruit Fly Strategy Action Plan, ABARES* report to client prepared for Plant Health Australia, Canberra, December.

ABARES project 43196

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)
Postal address GPO Box 1563 Canberra ACT 2601
Switchboard +61 2 6272 2010|
Facsimile +61 2 6272 2001
Email info.abares@daff.gov.au
Web daff.gov.au/abares

Acknowledgements

Our thanks to Plant Health Australia's Nicholas Woods and Rodney Turner for their invaluable insight, advice and guidance throughout the project, to staff in the state agricultural departments who provided data necessary for the analysis, and to Roberta Rossely and Lois Ransom from the Department of Agriculture, Fisheries and Forestry for their valuable suggestions.

Contents

Summary 1
1 Introduction 5
2 Background 6
Why are fruit flies a pest? 6
Affected horticultural industries 6
Current management of fruit fly 8
Origins of the Action Plan 10
3 Method of analysis 13
Costs 14
Benefits 14
4 Data and assumptions 16
Cost estimation 16
Benefits estimation 17
Other benefits 22
5 Results 24
Sensitivity analysis 25
Distribution of benefits from the Action Plan 27
6 Governance Body 29
Assessing the economic feasibility of a governance body 30
Appendix A: Summary of National Fruit Fly Strategy Action Plan projects 32
Appendix B: Statistical divisions managed for fruit fly free status 36
Appendix C: Theoretical framework for examining returns from Action Plan 37
References 39

Tables

Table 1 Action Plan projects contributing to saving categories 15
Table 2 Indicative Action Plan project costs 17
Table 3 Flow of benefits from Action Plan, by category 18
Table 4 Assumptions used for estimating benefits of draft National Fruit Fly Strategy and Action Plan 18
Table 5 Estimated annual costs of maintaining fruit fly free areas 20
Table 6 Expenditure on fruit fly management and R&D 21

Table 7 Average annual costs of eradicating Australian fruit flies from pest free areas 21
Table 8 Estimated annual benefits of Action Plan 24
Table 9 Estimated benefits of Action Plan implementation 25
Table 10 Results of benefits sensitivity to changes in key parameters 26
Table 11 Results of benefits sensitivity to different discount rates 26
Table 12 Governance Body investment thresholds 30
Table B1 Statistical divisions managed for fruit fly free status 36

Figures

Figure 1 Average value of major fruit fly susceptible horticultural production, by state, 2006–09 7
Figure 2 Average value of major fruit fly susceptible products in fruit fly free and endemic regions, 2006–09 7
Figure 3 National Fruit Fly Strategy Action Plan projects 12
Figure 4 Expected costs and benefits of investment in Action Plan over time 14
Figure 5 Estimated gross benefits for stakeholders from implementation of Action Plan 28
Figure 6 Proportion of benefits to stakeholders in fruit fly free and endemic regions 28
Figure C1 Estimated gross benefits–Action Plan versus National Fruit Fly Strategy 38

Boxes

Box 1 Industry good features of fruit fly management 10
Box 2 Framework for estimating Action Plan costs and benefits 14
Box 3 Potential benefits of the National Fruit Fly Governance Body 30

Summary

The Queensland fruit fly (Qfly), *Bactrocera tryoni* (Froggatt), and Mediterranean fruit fly (Medfly), *Ceratitis capitata* (Wiedemann) can cause significant damage to Australia's fruit and vegetable industries. Fruit flies inflict direct production losses and additional costs of pre and post-harvest treatment for fruit fly susceptible produce. The presence of these pests in production regions can lead to loss of produce from these areas or reduced access to national and international markets.

Fruit fly management works at an individual, industry and government level. In areas where fruit flies are found, landholders use sprays and traps to mitigate their effect. Industry and government fund R&D and management and maintenance of fruit fly free areas, such as the Sunraysia. Specific government programs include state-based surveillance and control, the Torres Strait containment strategy and, for outbreak eradication and area-wide control, production of non-fertile fruit fly to reduce fertile populations of Qfly or Medfly (DAFF 2007).

In 2006 international and domestic market access requirements for Australian horticultural products and the increasing cost of fruit fly incursions prompted Australian, state and territory governments and the horticulture industry to jointly review fruit fly management procedures. The review culminated in the 2010 National Fruit Fly Strategy Implementation Action Plan. The Action Plan provides a coordinated national approach to fruit fly management through 15 interconnected projects. These projects are based on findings from a review of 20 recommendations and 80 strategies outlined in the draft National Fruit Fly Strategy released by the Federal Minister for Agriculture, Fisheries and Forestry in 2008.

ABARES was engaged by Plant Health Australia to assess the potential benefits of implementing the Action Plan against the costs. The purpose of the analysis is to examine additional benefits that could be gained nationally through the coordinated Action Plan. Additional benefits are over and above existing benefits provided by fruit fly management programs.

The ABARES study aims to:

- provide a national overview of potential benefits and costs of the Action Plan
- identify the main potential beneficiaries of the Action Plan
- assess the feasibility of a proposed new management structure to implement the Action Plan
- identify and describe any other benefits of the Action Plan.

The Action Plan is designed to generate five categories of benefits:

- improved market access
- improved fruit fly management practices
- reduced production losses (quantity and quality)
- more efficient, nationally coordinated fruit fly management structures and improved coordination and prioritisation of research, extension and training activities
- improved emergency response arrangements.

This study uses a benefit–cost analysis framework to assess the economic feasibility of the Action Plan. The benefits or cost savings expected from the Action Plan are estimated using assumptions of key parameter values based on Plant Health Australia's 2009 benefit–cost analysis of the 2008 draft National Fruit Fly Strategy. The assumptions, developed after wide consultation with industry, government stakeholders and experts, cover parameters related to market access, production losses, operational management and emergency response capacity.

In this study, key parameter assumptions used in the 2009 benefit–cost analysis are adjusted downward. This takes into account the proposed investment in the Action Plan, which is lower than that proposed for the draft National Fruit Fly Strategy. The proposed total investment in the Action Plan over 20 years is $23.5 million, in present value terms. In contrast, the present value of the expected investment used in the 2009 benefit–cost analysis was $50 million. Consequently, key parameter values from the earlier study are reduced by 10 per cent for what is termed a high scenario and 30 per cent for what is termed a low scenario.

This study makes some general assumptions consistent with the benefit assessment of the National Fruit Fly Strategy by Plant Health Australia (2009):

- Implementation of the Action Plan does not affect domestic prices of fruit fly susceptible products.
- Without the Action Plan, the mix and volume of fruit fly susceptible products produced and exported remain at current levels during the analysis period.
- Price premiums for access to markets with fruit fly phytosanitary measures are unchanged.
- Without the Action Plan, technology for fruit fly management is unchanged through time.

Results of the ABARES study

Annual benefits of implementing the Action Plan are estimated at $29.2 million for the low scenario and $37.5 million for the high scenario. The largest gains expected are reduced production losses, savings from improved operational management, and improved market access.

Source of annual benefits	Action Plan Low scenario ($m)	Action Plan High scenario ($m)
Improved market access	5.7	7.3
Improved operational management practices	8.9	11.5
Reduced production losses	9.3	12.0
Enhanced management structures, R&D, extension and training	3.6	4.6
Improved emergency response capability	1.6	2.1
Total	29.2	37.5

Source: ABARES

The present value of estimated gross benefits from the Action Plan over 20 years is $286 million, with a benefit–cost ratio of 12.1:1 for the low scenario. Taking into account the expected cost of the investment, the net present value of the Action Plan under this scenario is estimated at $262.2 million.

Under the high scenario, the estimated present value of gross benefits is $367 million, with a benefit–cost ratio of 15.6:1. Taking into account the expected cost of the investment, the net present value under this scenario is estimated at $343.8 million.

The estimated benefit–cost ratio for the Action Plan is higher than the estimated benefit–cost analysis of 8.3:1 in the 2009 Plant Health Australia study. However, the net present value is lower than the $365 million estimated in the earlier study. These results are consistent with the principle of a diminishing marginal return on investment, given that the Action Plan is made up of higher priority projects from the 2008 draft National Fruit Fly Strategy.

ABARES conducted an analysis of sensitivity of results to the discount rate, project cost and the three main drivers of benefits—lower production loss, increased market access and lower operational management costs. Results suggest that, even with variations in the underlying parameters, the Action Plan will generate significant gains.

The Action Plan could provide spillover benefits. For example, improved fruit fly management of commercial farms may advantage backyard growers. Other sectors may gain from the increased marketable production resulting from the Action Plan.

Benefits to stakeholders

Distribution of benefits from the Action Plan is estimated for the three main stakeholders—industry, the Australian Government, and state and territory governments. The benefits to stakeholders will vary depending on whether they are in pest-free areas or an endemic region. However, it is generally assumed that the horticulture industry will benefit from avoided production loss and gains in export value from improved international market access. The avoided operational costs for pre and post-harvest in endemic regions were also assumed to accrue to industry.

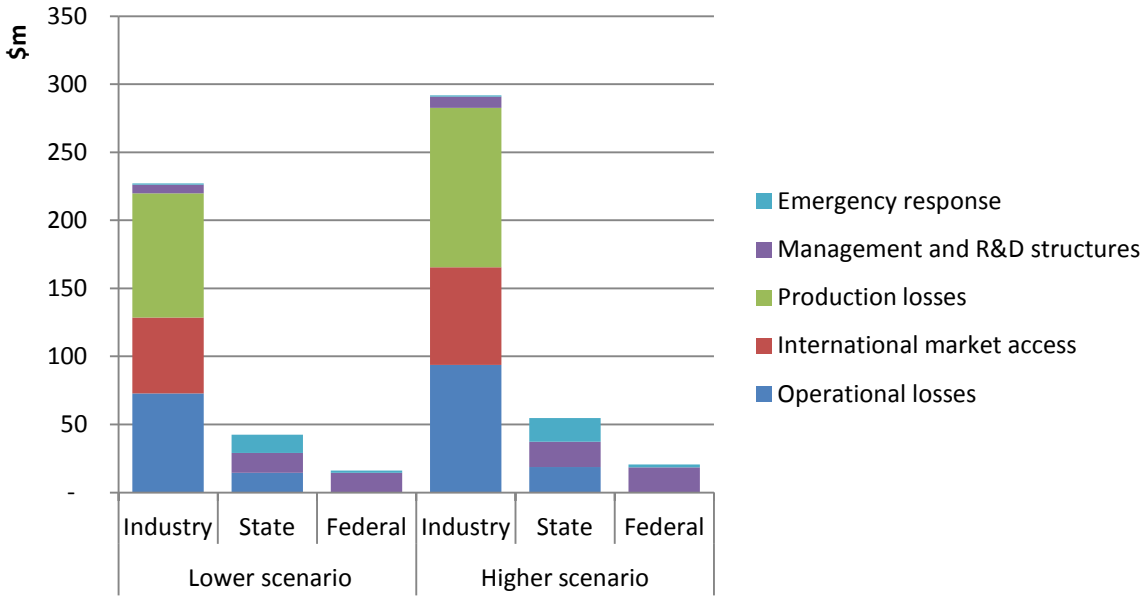
State and territory governments are expected to benefit from reduced operational costs of maintaining pest-free areas and eradication of endemic fruit fly. Savings in the cost of management, R&D and eradication of exotic fruit fly are assumed to be shared by all parties.

Over 20 years it is estimated the total gross benefit or savings would be divided, for the low and high scenarios respectively, between:

- $227 million to $292 million to fruit fly susceptible industries from avoided production losses, savings in pre and post-harvest treatment and gains in export value through improved market access
- $43 million to $55 million to state and territory governments from reduced operational costs of maintaining pest-free areas, reduced costs for emergency response and management, and more cost-effective R&D
- $16 million to $21 million to the Australian Government from reduced costs for emergency response and management, and more cost-effective R&D.

These values represent estimated shares of the aggregate gross benefit from the Action Plan accruing to these parties. The cost of investment in the Action Plan made by each party is not taken into account in these calculations.

Estimated gross benefits of Action Plan for stakeholders



Source: ABARES

Most benefits will flow to industry because the largest gains are likely to be reduced production losses, improved market access and savings in pre and post-harvest treatment of produce. This is consistent with the 'industry good' characteristics of fruit fly management whereby producers benefit significantly from acting collectively.

National Fruit Fly Governance Body

The Action Plan proposes the establishment of an independent National Fruit Fly Governance Body to coordinate implementation of projects outlined in the Plan and ensure cooperation between Australian horticulture industries and governments.

It is difficult to isolate the benefits of the proposed Governance Body from the overall benefits that the Action Plan is expected to provide. Given these limitations, a threshold approach is used to assess the economic feasibility of such a body. To be economically feasible, the benefits the Governance Body delivers (improved efficiency in delivering the Action Plan) must outweigh the cost of its establishment.

The total proposed cost of the Governance Body over 20 years is $3.9 million (in 2011–12 dollars). This represents, at a maximum, 1.5 per cent of the potential gains for the low scenario. This suggests that if there were a 100 per cent probability that the Action Plan could not be implemented efficiently without a governance body, and that net benefits would decline by more than 1.5 per cent, then the benefits would outweigh the costs of investment in a governance body. Alternatively, if the probability were 50 per cent, it would require more than a 3 per cent reduction in benefits for the body to be justified.

1 Introduction

Fruit flies can cause significant damage to Australia's economically important fruit and vegetable industries. In 2006 the Commonwealth and state governments and the horticulture industry initiated a wide ranging review of management procedures for fruit fly. The outcome of the review was the 2010 National Fruit Fly Strategy Implementation Action Plan (Action Plan).

ABARES was engaged by Plant Health Australia to assess potential benefits and costs of implementing the Action Plan.

The assessment described in this report aims to:

- provide a national overview of potential quantifiable benefits and costs of the Action Plan
- identify main potential beneficiaries of the Action Plan
- assess the feasibility of a proposed management structure that will oversee implementation of the Action Plan
- identify and describe any other potential non-quantifiable benefits of the Action Plan.

Chapter 2 outlines the fruit fly situation in Australia and likely effects of fruit fly outbreaks on horticultural industries and regional and other economies. Also summarised are current fruit fly management arrangements and projects proposed in the Action Plan.

Chapter 3 describes the model used to estimate the net present value of benefits and benefit–cost ratio of implementing the Action Plan, along with key assumptions underpinning the model.

Chapter 4 sets out assumptions and data used in estimating benefits of the Action Plan. The nature and scope of potential spillover benefits from the Action Plan are also discussed.

Chapter 5 presents the results of a benefit–cost analysis and a beneficiary analysis. Chapter 6 examines the economic feasibility of establishing an independent National Fruit Fly Strategy Governance Body to administer the Action Plan.

2 Background

Why are fruit flies a pest?

Fruit flies can cause significant damage to Australia's valuable fruit and vegetable industry. Female fruit flies lay eggs in the host produce, larvae hatch and eat their way out, damaging the flesh and causing rot from the inside out (Harvey et al. 2010). If infested produce is untreated, production losses can reach 100 per cent (Biosecurity Australia 2008).

Most of the 150 endemic or established species of fruit fly in Australia do not attack commercial crops (DAFF 2009). However, Queensland fruit fly (Qfly), *Bactrocera tryoni,* and the Mediterranean fruit fly (Medfly), *Ceratitis capitata* can have a major economic effect on fruit and vegetable production and thereby adversely affect market access. Australia also remains at risk of incursion from exotic fruit flies in South-East Asia and the South Pacific region (DAFF 2009).

Qfly occurs in large populations throughout eastern Australia, from Cape York in Queensland to East Gippsland in Victoria. Medfly is confined to Western Australia—in the horticultural and urban areas of the south-west and isolated urban communities in northern coastal towns.

Effective management of fruit fly is of central concern to Australian horticulture industries because of the adverse effect the pest can have on the cost of production and on market access (NFFSIC 2010). Pre-harvest treatments, such as baits and insecticides, are needed to avoid production losses in areas where fruit flies are present. These chemical or physical treatments are costly and can leave residue or cause quality issues that reduce the marketability of produce (DAFF 2010). Production losses attributable to fruit fly in endemic areas are estimated to range from 0.5 to 3 per cent annually, depending on the type of crop, and despite ongoing pest control efforts (PHA 2009).

The presence of fruit fly can also limit access of fruit fly susceptible horticulture products to some domestic and international markets. Some regions within Australia and certain export markets enforce strict phytosanitary measures to protect their domestic horticulture production from fruit flies. For example, fruit fly susceptible produce transported into South Australia and Tasmania, and exported from Australia to international markets (such as the United States and Japan), are subject to phytosanitary requirements (Harvey & Fisher 2010).These measures can include the requirement that produce is sourced only from areas recognised to be fruit fly free or post-harvest treatment requirements, such as cold disinfestations to kill eggs and larvae (DAFF 2010).

As well as the benefits from increased market access, produce from fruit fly free areas can attract a price premium in lucrative export markets (Access Economics 2010). Producers in these regions have the added commercial benefit of selling their produce without costly pre and post-harvest treatment.

Affected horticultural industries

Major horticulture industries at risk from fruit fly outbreaks in Australia are the citrus, pome, stone fruit, grape, berry, tropical fruit and vegetable industries. Vegetable produce includes tomatoes, capsicum, chilli and eggplant.

Between 2006 and 2009, for example, the average annual value of fruit fly susceptible production in Australia was approximately $5.3 billion, with the majority of production in Queensland, Victoria, South Australia and New South Wales (Figure 1) (ABS 2010b).

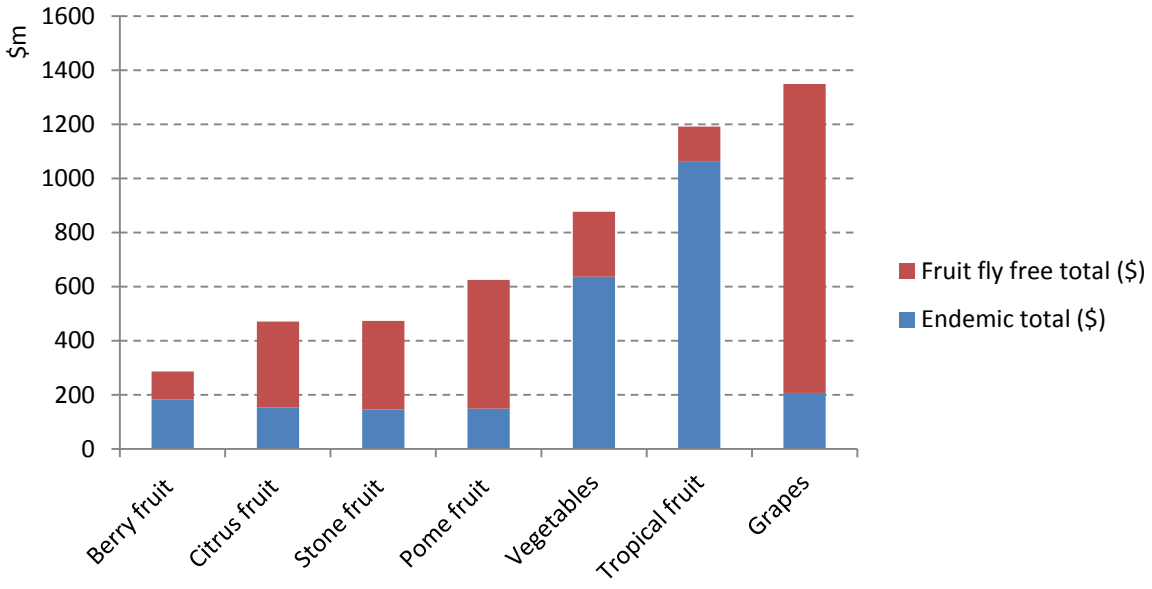
Figure 1 Average value of major fruit fly susceptible horticultural production, by state, 2006–09

Source: ABARES

Around 51 per cent of this production occurred in fruit fly free regions. Within these regions, grapes had the highest annual gross value of production at around $1.2 billion, followed by pome fruit ($476 million), stone fruit ($327million) and citrus ($317 million).

In fruit fly endemic regions, tropical fruit had the highest gross value of production ($1.1 billion), followed by vegetables ($636 million) and grapes ($206 million) (Figure 2). Around 80 per cent of fruit fly susceptible products are traded domestically (Kalang Consultancy Services 2008).

Figure 2 Average value of major fruit fly susceptible products in fruit fly free and endemic regions, 2006–09



Source: ABARES

Current management of fruit fly

Australian fruit fly management plans and legislative frameworks vary across states and territories (ABARE 2005). Coordination and application of fruit fly management strategies vary accordingly.

Management strategies designed to reduce the impact of fruit fly and impede its spread to unaffected areas include:

- quarantine restrictions
- monitoring and surveillance
- response and eradication
- ongoing control.

Quarantine restrictions
This strategy is designed to reduce the risk of fruit infested with fruit fly entering the country or state. Importation of fruit to Australia is controlled by the *Quarantine Act 1908*. Import risk assessments are used to examine the risk of entry, establishment and spread of pests, including fruit fly. If the risks are above the 'very low' score, then pre-border treatments may be required or access denied under the Act.

Domestically, quarantine management systems reflect the use of the Code of Practice for Queensland and Mediterranean fruit fly as a national standard. Harmonisation of interstate trade is facilitated though the Domestic Market Access Working Group and Plant Health Committee. Each state and territory uses different approaches and legislation to apply quarantine restrictions. For example, South Australia's front-line fruit fly protection is provided by roadblocks with quarantine inspectors, honesty bins located on highway entry points, and random mobile roadblocks throughout the state (Biosecurity SA 2012). In Victoria, quarantine fruit disposal bins are strategically placed throughout the state and roadblocks operate on country roads at strategic times of the year (Quarantine Domestic 2012).

Monitoring and surveillance
This strategy aims to detect fruit fly outbreaks at an early stage, helping to improve the effectiveness of control efforts. The Long-Term Containment Strategy for Fruit Flies in Torres Strait provides border quarantine, permanent monitoring, response activities and public awareness campaigns designed to keep Australia free of exotic fruit fly that pose a threat to horticulture. State and territory based monitoring and surveillance is largely carried out using a network of traps, including at ports. In Victoria, this network is maintained within all production and urban areas across the state to support area freedom certification for fruit fly susceptible produce.

Response and eradication
Such strategies are used to limit the effect of incursions and outbreaks of both exotic and endemic fruit fly. Government and industry take joint action in response to incursions of exotic fruit fly species. The *Emergency Plant Pest Response Deed* sets out cost-sharing arrangements and covers management and funding of responses to incursions of exotic fruit fly, such as the papaya fruit fly(eradicated using similar management principles before the deed became operational) (PHA 2011). Exotic fruit fly are generally classified as Category 2 pests under the

deed and therefore 80 per cent of funding is public and 20 per cent private; this ensures a technically feasible rapid eradication response.

For outbreaks of endemic or established fruit fly, state governments use a number of approaches as part of a response strategy, including sterile insect technique (SIT). SIT is used for area-wide control of Medfly in Western Australia, and in South Australia for eradication of Qfly and Medfly. South Australia contributes funding to sterile Qfly production in New South Wales and to sterile Medfly production in Western Australia (DAFF 2007).

Ongoing control

This strategy helps reduce the effect of fruit fly nationally. The tri-state Fruit Fly Exclusion Zone is an example of collective action to coordinate fruit fly management across a large geographical area. The initiative aims to maintain a substantial portion of southern New South Wales, much of Victoria and all of South Australia as fruit fly free, with occasional small outbreaks eradicated soon after detection. Cost-sharing allows control of a greater area than would have been possible for growers in individual states, enabling all growers in a region to access international and domestic markets with stringent fruit fly phytosanitary requirements (Access Economics 2010).

Producers are responsible for fruit fly management outside the Fruit Fly Exclusion Zone. In these regions, management is undertaken using pre and post-harvest treatment, and orchard maintenance, such as tree pruning and disposal of fallen fruit. For example, if fruit flies are detected in stone fruit in an endemic area, a baiting program may be used until harvest is complete. Other pre-harvest treatment options include baiting and cover sprays.

Fruit flies are highly mobile—capable of flying short distances or being transported over long distances through the movement of produce (ABIN 2011). Fruit fly management decisions can therefore have significant effects beyond any single grower or state. For instance, the surveillance and control programs used in Victoria and New South Wales play a role in the management of Qfly levels in south-eastern Australia, while the efforts in Victoria are also instrumental in keeping Tasmania fruit fly free (N Woods, PHA 2012, pers. comm.). South Australia provides an important buffer zone to the eastern states from Medfly infestation from Western Australia (Access Economics 2010).

Collective or joint action in fruit fly management helps reduce shared risk posed by fruit fly (Access Economics 2010)—the characteristics of an industry good (Box 1). Australian, state and territory governments have worked closely with industry over several years to overcome the potential market failure in fruit fly management in Australia that can result from shared risk (Access Economics 2010).

An objective of the proposed Action Plan is to adapt the institutional framework so the various elements of fruit fly management can be better coordinated nationally. This analysis examines the additional benefits that would be generated by Action Plan projects, not the benefits and costs of existing fruit fly management programs.

Box 1 Industry good features of fruit fly management

An industry good is similar to a public good in that it is both non-excludable and non-rivalrous. That is, consumption of the good by one person does not exclude others from its consumption, and consumption by one person does not diminish the amount available to anyone else (Schotter 2003).

However, unlike a public good, where benefits are widely diffuse and there is no market mechanism through which private investors could obtain appropriate returns to their investment, the benefits from an industry good can be directly and fully apportioned to a specific industry or industries. For example, benefits from fruit fly management will accrue directly to growers in the industry in the form of lower horticulture production losses and improved market access.

Many aspects of fruit fly management have a strong industry good component in that without collaborative efforts, individual growers may 'free ride' on the efforts of others managing fruit fly on their properties. That is, individual growers in an industry would under-provide fruit fly management if it was left as a private decision, even though there may be significant benefits to the industry acting collectively.

In some circumstances, government action may be required to support the provision of industry goods. For example, where it is not practical or cost-effective for industry to administer, government could legislate for a user-pays system, a compulsory levy on growers that would support an industry good (Productivity Commission 2010). In other cases, where a government service is required to provide the industry good, the cost of provision can be recovered through direct user charging for services, such as for phytosanitary export inspections and certification.

Governments and industry sometimes share the cost of fruit fly management, as in the case of the *Emergency Pest Plant Response Deed*. This agreement recognises that without prompt eradication an outbreak of exotic fruit fly on one property can undermine the pest-free status of an entire region or state, excluding all growers in the region or state from accessing domestic and international markets with phytosanitary requirements for fruit fly (Access Economics 2010). Another example of cost sharing is the joint provision of funding for agriculture R&D under the *Primary Industries and Energy Research Development Act 1989*.

Origins of the Action Plan

International and domestic market access requirements for Australian horticultural exports and the increasing cost of fruit fly outbreaks prompted governments and industry to develop a coordinated national approach to fruit fly management (PHA 2010). A National Fruit Fly Strategy steering committee was set up in 2006 to review fruit fly management and report on ways to achieve a national approach to managing the pest.

In November 2008 the steering committee released the draft National Fruit Fly Strategy. The strategy aimed to deliver a 'viable, cost-effective and sustainable national approach to fruit fly management to minimise constraints on sustainable production and barriers to national and international market access that fruit flies currently impose on the Australian horticultural industries' (PHA 2008). Australian, state and territory governments, horticulture industry and industry R&D organisations contributed to the draft's 20 recommendations and 80 strategies covering major operational, policy and research concerns.

Following the release of the draft National Fruit Fly Strategy, an implementation committee was set up to review and prioritise the draft recommendations and strategies. In 2009, to help guide the committee, Plant Health Australia conducted a benefit–cost analysis, *Economic assessment of implementation of the proposed National Fruit Fly Strategy: Part 1* (PHA 2009). The analysis estimated costs and benefits of implementing all 80 strategies proposed in the draft. Plant Health Australia consulted with stakeholders and experts to formulate conservative assumptions for the analysis parameters.

The National Fruit Fly Strategy Implementation Action Plan was released in April 2010. The strategies of highest priority from the 2008 draft National Fruit Fly Strategy formed the basis for new projects that would facilitate implementation of a more effective national approach to fruit fly management.

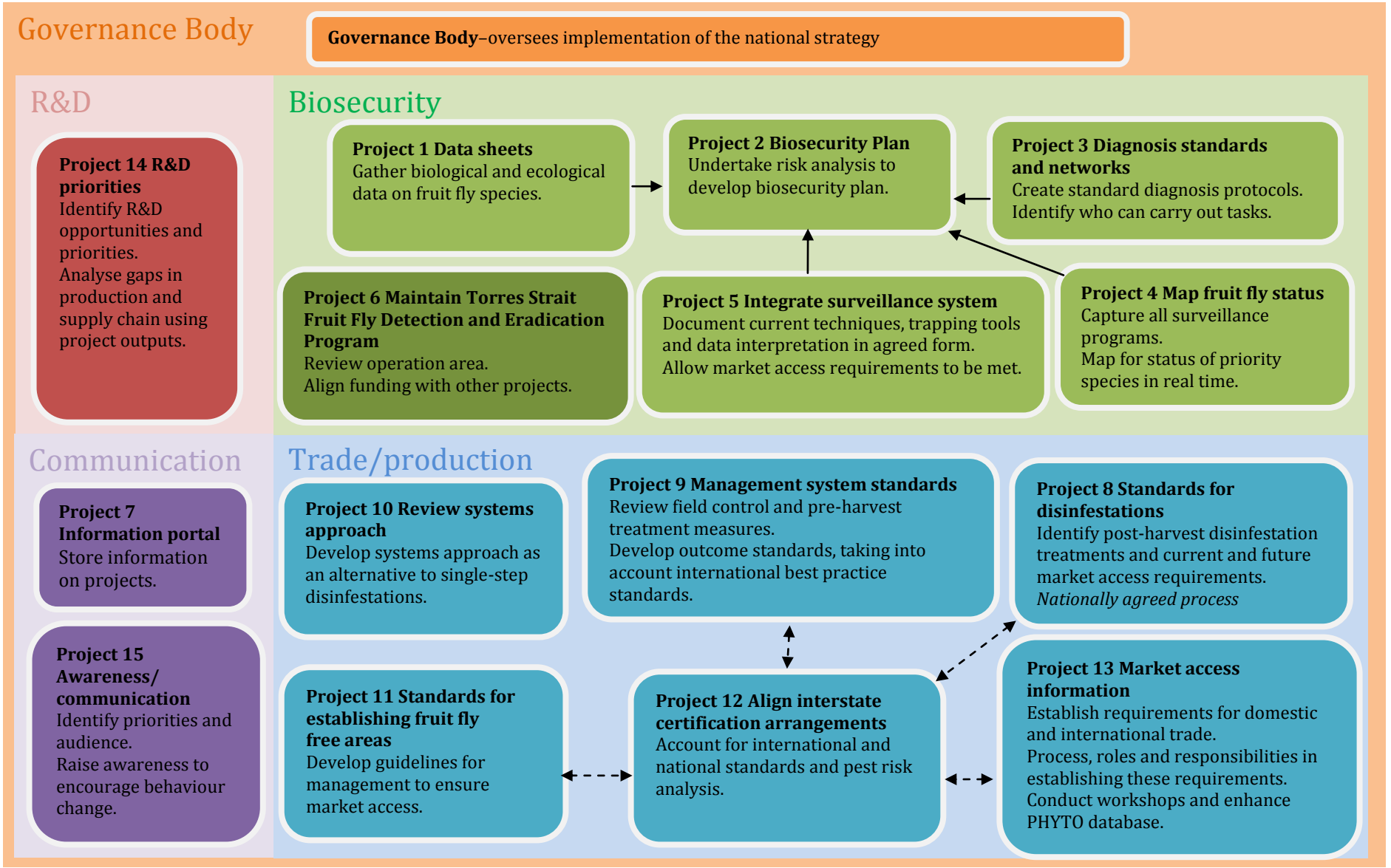
The Action Plan Implementation Committee identified 15 projects (Figure 3; Appendix A) that focus on five main themes across the supply chain:

- fruit fly biosecurity
- fruit fly management
- market access
- communications and awareness
- research and development.

The 15 projects form an integrated package. In Figure 3 linkages between projects within a theme are indicated by arrows. For some projects these interconnections are stronger than others. For example, projects contributing to fruit fly management and market access themes are strongly interconnected and have therefore been grouped under Trade/production. Plant Health Australia's (2009) benefit–cost analysis of the 2008 draft National Fruit Fly Strategy also considered strategies and projects as an integrated package (NFFSIC 2010).

The Action Plan Implementation Committee recommended establishing an ongoing national governance body to administer the projects. This was also a recommendation of the 2008 National Fruit Fly Strategy (NFFSIC 2010).

Figure 3 National Fruit Fly Strategy Action Plan projects



3 Method of analysis

This assessment uses benefit–cost analysis to assess the economic feasibility of the proposed Action Plan. This method allows expected benefits of implementing the Action Plan to be compared with proposed investment. Potential benefits or savings are estimated relative to the current fruit fly management situation (Box 2).

This analysis builds on Plant Health Australia's benefit–cost analysis of the 2008 draft National Fruit Fly Strategy (PHA 2009), which used extensive stakeholder consultation to reach agreement on appropriate key parameter assumptions for estimating the benefits of the draft strategy. The National Fruit Fly Strategy Implementation Committee reviewed and supported Plant Health Australia's (2009) analysis.

Some constraints were experienced in undertaking this analysis. First, sufficient information was not available to assess the degree by which the smaller investment envisaged for the Action Plan would reduce expected benefits, compared with the larger investment proposed for the 2008 draft National Fruit Fly Strategy. Second, it was not feasible to reconvene the same stakeholders and members of the National Fruit Fly Strategy Implementation Committee to get consensus on key parameter assumptions for estimating benefits from the 15 Action Plan projects.

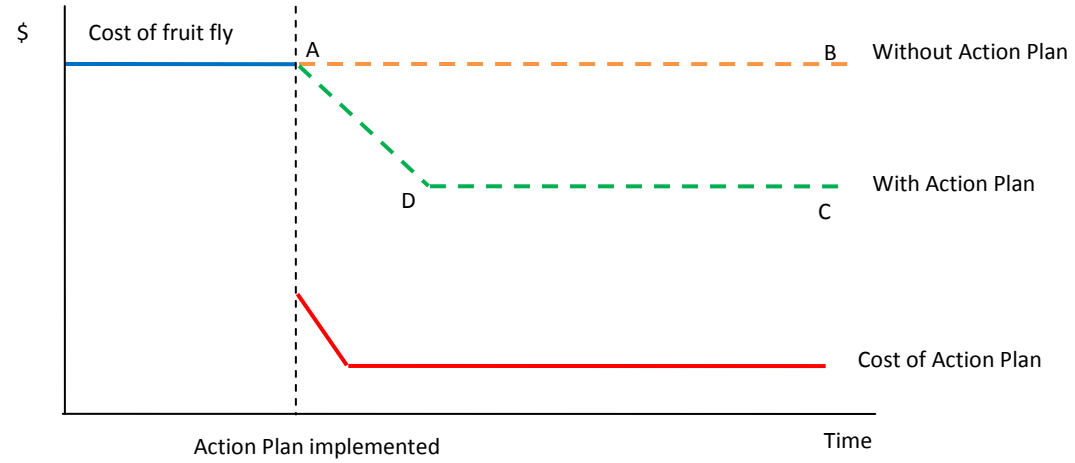
Given these constraints, similar parameter assumptions are used in this study, with the addition of three new elements:

- key parameters from the earlier study are reduced by 10 per cent for what is termed high scenario and 30 per cent for what is termed low scenario to account for the lower proposed investment in the Action Plan
- production and trade data on fruit fly affected crops and the cost of managing fruit fly have been updated from that used in the Plant Health Australia (2009) study
- a sensitivity analysis has been undertaken as part of this study to account for uncertainty in key parameter assumptions.

Box 2 Framework for estimating Action Plan costs and benefits

Costs and benefits of implementing the Action Plan are estimated relative to existing national management of fruit fly. Based on work by Plant Health Australia (2009), the Action Plan is expected to generate savings or benefits by reducing three main costs—the cost of fruit fly management, market access cost and production losses. The simplified illustration shows how the economic feasibility of the Action Plan is examined. Savings generated by the Action Plan over time are represented by the area ABCD, while the area under the cost curve represents the cost of implementation. The difference between these two areas represents the net effect (economic gain or loss) of implementing the Action Plan.

Figure 4 Expected costs and benefits of investment in Action Plan over time



Source: ABARES

Costs

Costs considered in the analysis are the costs of implementing 15 projects and the proposed Governance Body. These costs were provided by Plant Health Australia following consultation with stakeholders. The costs of implementing the Action Plan are expected mainly in the first three years, with minor ongoing costs.

Benefits

Benefits or savings likely to be generated by Action Plan projects are divided into five broad categories (NFFSIC 2010):

- savings in market access costs in both export and domestic markets, and higher returns from sales to premium price markets
- savings from improved fruit fly operational management practices, such as management of pest-free areas and pre and post-harvest treatments outside fruit fly free areas
- savings from reduced production losses (quantity and quality) in fruit fly susceptible crops outside fruit fly free areas
- savings from more efficient and coordinated fruit fly management structures and improved research, extension and training activities
- savings from improved emergency response arrangements, such as detection and eradication.

Action Plan projects contribute to more than one benefit category (Table 1) and each category is contributed to by more than one project. As a result, the benefits of undertaking Action Plan projects cannot be examined separately and are therefore estimated as a whole.

In this analysis, benefits generated by the Action Plan for each category are quantified using adjusted assumptions from the Plant Health Australia benefit–cost analysis (PHA 2009). These assumptions were adjusted to take into account differences in the proposed level and composition of investment between the 2009 study and this analysis of the Action Plan. This analysis examines two scenarios representing different levels of attainment of the benefits of the 2008 draft National Fruit Fly Strategy (see Chapter 4).

Under each scenario, it is assumed that benefits from all sources would decline by the same percentage. This is based on the expectation that the optimal path of investment (for every level of investment) would trace a balanced expenditure on all benefit sources. That is, the investment occurs such that, at each level of expenditure, the obtainable benefits from a dollar invested in each source are equal.

As in the 2009 benefit–cost analysis (PHA 2009), it is assumed that the full gains or benefits of implementing the Action Plan will be generated four years after the start of each Action Plan project, thereby allowing time for the uptake of technologies and change in management practices.

Table 1 Action Plan projects contributing to saving categories

Projects a	Market access	Operational management	Management structures and R&D	Emergency response	Production loss
1	–	x	x	x	–
2	–	–	–	x	–
3	x	x	–	x	–
4	x	x	x	x	–
5	x	x	x	–	–
6	x	–	–	x	x
7	–	x	x	–	–
8	x	x	–	–	–
9	x	x	–	x	x
10	x	x	–	–	–
11	x	x	–	x	x
12	x	–	x	–	–
13	x	–	x	–	–
14	–	–	x	–	–
15	–	–	x	–	–

a Project titles listed in Figure 3 are described in Appendix A. x Project contributing to a savings category.

Source: ABARES based on National Fruit Fly Strategy Implementation Committee 2010

4 Data and assumptions

In this analysis, benefits and costs of the Action Plan are assessed over a 20-year period. This time frame has been chosen because it is consistent with the investment planning horizon used for stone, pome fruit and vineyards (Ha et al. 2009). A discount rate of 7 per cent is used to estimate the present value of benefits and costs over this period, based on the *Australian Government 2010*, *Best Practice Regulation Handbook* (Australian Government 2010). The cost and benefit estimation process, and data are outlined in this chapter.

Cost estimation

Costs of implementing the Action Plan include the costs of each project and the cost of establishing and operating a governance body. The Implementation Committee recognised that some projects and tasks would benefit from being implemented quickly to address current issues (NFFSIC 2010); for this reason, some projects will be fully implemented within one to two years. Based on consultation with stakeholders, Plant Health Australia estimated the cost of investment in Action Plan projects, which occur in the first three years (Table 2). The total present value of the cost of implementing all projects is estimated at $19.6 million. Plant Health Australia was unable to provide estimates of any ongoing project costs and has advised that any additional costs beyond the implementation period would be minor.

If there were significant ongoing costs, however, potential net benefits in this analysis could be overestimated. The likely impact of potentially higher costs on net benefits is explored in the sensitivity analysis section.

The Governance Body's role in coordinating a national approach to fruit fly management is expected to continue for the 20-year planning horizon (N Woods, PHA 2011, pers. comm. 25 November). Two alternative models are proposed:

- Governance Body–Model A: costing $350 000 a year, over 20 years, at a present value of $3.9 million
- Governance Body–Model B: costing $150 000 a year, over 20 years, at a present value of $1.7 million.

The maximum total cost of implementing the Action Plan (with a coordinating governance body) is estimated at $23.5 million in present value terms. In contrast, the present value of investment on the 2008 draft National Fruit Fly Strategy was estimated at $50 million over 20 years.

Table 2 Indicative Action Plan project costs

Projects	2011–12 ($'000)	2012–13 ($'000)	2013–14 ($'000)	Ongoing annual ($'000)	Present value* ($'000)
1	155	155	5	–	304
2	120	120	120	–	337
3	80	70	70	–	207
4	200	200	200	–	562
5	75	75	75	–	211
6	350	200	200	–	712
7	130	100	100	–	311
8	918	768	768	–	2307
9	2700	2300	1100	–	5810
10	2860	1430	715	–	4821
11	1230	615	308	–	2073
12	300	200	–	–	487
13	300	–	–	–	300
14	100	100	100	–	281
15	300	300	300	–	842
Total	9818	6633	4061	–	19 564
Governance Body–Model A	350	350	350	350	3967
Governance Body–Model B	150	150	150	150	1700

Note: * For the year 2011–12

Governance Body–Model A is a steering committee, with three full-time Plant Health Australia staff.

Governance Body–Model B is a steering committee with a Plant Health Australia secretariat.

Source: Plant Health Australia estimates based on stakeholder consultations

Benefits estimation

Quantifiable benefits or savings of implementing the Action Plan are expected to be generated by:

- improved market access
- improved fruit fly management practices
- reductions in production losses
- more efficient and coordinated fruit fly management structures
- improved emergency response arrangements.

Based on the assumptions of Plant Health Australia (2009) benefits from these five categories are assumed to flow to areas that are considered to be fruit fly free and areas that are outside this region—fruit fly endemic (Table 3).

For this analysis, areas that are fruit fly free were determined based on the traditionally maintained pest-free regions in Victoria, New South Wales and South Australia (Appendix B). Because it is difficult to predict outbreaks, it is assumed that their frequency in these fruit fly free areas will remain constant, without the Action Plan.

Table 3 Flow of benefits from Action Plan, by category

Benefit source		Fruit fly free area	Fruit fly endemic area
Improved market access		x	x
Improved operational management practices	Pre-harvest	–	x
	Post-harvest	–	x
	PFA management	x	–
Reduced production losses		–	x
Enhanced management structures, research and development, extension and training		x	x
Improved emergency response capability	Endemic	x	–
	Exotic	x	x

PFA = Pest-free areas

Source: ABARES

The benefit scenarios examined in this analysis are based on assumptions used in Plant Health Australia (2009) about expected benefits or savings generated by each category. The assumptions were adjusted downward—to reflect the reduced proposed investment in the Action Plan—at a proportionally smaller rate than the rate of decline in investment (of over 50 per cent) based on the following:

- successive units of investment yield lower returns under the principle of diminishing marginal returns on investment (Appendix C)
- the Action Plan is made up of higher priority projects from the draft National Fruit Fly Strategy.

A range for benefits is set around a point estimate obtained from this procedure at high and low benefit scenarios. In the high benefit scenario, assumptions were reduced by 10 per cent, while in the low benefit scenario they were reduced by 30 per cent (Table 4).

Table 4 Assumptions used for estimating benefits of draft National Fruit Fly Strategy and Action Plan

		Action Plan a		NFFS b
Benefit category	Assumptions	High scenario (%)	Low scenario (%)	(%)
Savings from improved market access	Increase in the export value of fruit fly susceptible horticultural produce	9	7	10
Savings from improved operational management	Reduction in average annual operational costs	13.5	10.5	15
Savings from reduced production losses	Reduction in production losses (both in quantity and quality)	36	28	40
Savings from more coordinated fruit fly management structures and improved R&D	Improvement in the efficiency of management and R&D operations for fruit fly	18	14	20
Savings from improved emergency response arrangements	Reduction in potential costs incurred from a fruit fly incursion (exotic and endemic species)	18	14	20

a ABARES 2012. b Plant Health Australia 2009 report on the draft National Fruit Fly Strategy.

A number of other general assumptions consistent with the benefit assessment of the National Fruit Fly Strategy by Plant Health Australia (2009) are made:

- Benefits from each of these categories will gradually increase over time. Over the first four years of project implementation, the proportion of benefits realised will increase in increments of 20 per cent, before reaching maximum benefit in the fifth year and remaining constant thereafter.
- Implementation of the Action Plan will not affect domestic prices of fruit fly susceptible products.
- Without the Action Plan, the mix and volume of fruit fly susceptible products and exports will remain at current levels during the analysis period.
- Price premiums for access to markets with fruit fly phytosanitary measures will not change.
- Without the Action Plan, technology for fruit fly management will not change through time.

To put the assumptions into context, a summary of expected benefits from implementing the Action Plan are presented under each benefit category.

Savings from improved market access

The average annual value of exports of fruit fly susceptible horticulture products between 2006 and 2009 is estimated at $406.9 million (ABS 2010a). Around 20 per cent of this value is estimated to be from fruit exported to international markets with fruit fly phytosanitary requirements (PWC 2001 & PHA 2009).

Many trading partners are increasing their fruit fly phytosanitary requirements and demanding greater supporting scientific data (NFFSIC 2010). For this reason, several projects are designed to generate benefits from improving the ability of industries to maintain and increase access to national and international markets with fruit fly phytosanitary requirements (Table 1).

The Plant Health Australia (2009) study assumed the 2008 draft National Fruit Fly Strategy would increase industry returns from these markets by 10 per cent. In this analysis, it is assumed the Action Plan will increase industry returns by between 7 and 9 per cent.

Savings from improved operational management

Several Action Plan projects aim to reduce the three main sources of operational management costs (Table 1):

- maintaining pest-free area status (PFAs)
- undertaking pre-harvest treatment
- undertaking post-harvest treatment.

Based on adjusted Plant Health Australia (PHA 2009) assumptions, implementation of the Action Plan in this study is assumed to reduce these sources of operational management costs by 10.5 per cent (low scenario) and 13.5 per cent (high scenario).

The level of current expenditure on maintaining various areas free of the pest is based on Plant Health Australia (2009), with data updated where relevant (Table 5).

Table 5 Estimated annual costs of maintaining fruit fly free areas

Area	Expenditure ($m)
Fruit Fly Exclusion Zone a	7.02
Area freedom in Tasmania b	1.65
Area freedom in Western Australia b	0.55
Area freedom in South Australia b	5.00
Total cost of maintaining area freedom b	14.22

a Data provided by Plant Health Australia 2009. b Data provided by state governments 2011.

Pre-harvest treatment is required in production areas where fruit flies are found. Under the status quo, total annual expenditure on pre-harvest treatment is estimated as the cost per hectare of treatment multiplied by the area requiring treatment. The annual cost of bait and cover spraying averages $269 a hectare for most crops (PHA 2009). Spraying is required for susceptible crop production in areas not recognised as fruit fly free. Between 2006 and 2009, the average production area requiring spraying was 178 520 hectares (ABS 2010a).

Post-harvest treatment is required for produce transported interstate from areas outside the recognised fruit fly free area. Under the status quo, total annual expenditure on post-harvest treatment is estimated at $62.36 per tonne of treatment (PHA 2009) for cold and chemical treatment. Between 2006 and 2009 endemic areas accounted for 1.4 million tonnes of fruit fly susceptible produce (ABS 2010a), of which it is assumed some 26 per cent was sold interstate (PHA 2009 & Macarthur Consulting 1998).

Goodwin (2012) suggests that changing approaches to post-harvest treatment could increase operational costs for fruit fly susceptible produce. In October 2011 the Australian Pesticides and Veterinary Medicines Authority suspended the use of the chemical dimethoate on some produce and signalled likely restrictions on the use of fenthion. Growers may have to look at alternative methods of treatment, such as heat, cold, fumigation and, potentially, irradiation; an area for further research is the effect of such changes on potential operational savings generated by the Action Plan.

Savings from reduced production losses

It is estimated that on average $2.6 billion of fruit fly susceptible produce was grown in fruit fly endemic regions between 2006 and 2009 (ABS, 2010c). Following Plant Health Australia's (2009) medium expectations, current annual production losses in these regions are estimated to range from 0.5 to 3 per cent, depending on the commodity and the severity of the effect of fruit flies.

In the 2009 benefit–cost analysis, it was assumed production losses would be reduced annually by 40 per cent (PHA 2009). In the ABARES study, the Action Plan is assumed to reduce production losses by 28 and 36 per cent for the low and high scenarios, respectively.

Savings from improved fruit fly management and R&D structures

The Action Plan is expected to deliver savings through reduced duplication of R&D activities and improved efficiencies resulting from better communication and coordination of resources between jurisdictions (PHA 2009). Expenditure data for fruit fly management and R&D activities by the Australian, state and territory governments is based on DAFF (2007) (Table 6).

Table 6 Expenditure on fruit fly management and R&D

Activity area	Total cost (2003–08) ($)	Average annual costs ($)
Market access	746 500	149 300
Operational	62 616 655	12 523 331
Regulatory	41 774 809	8 354 962
Research and development	22 832 588	4 566 518
Other	718 516	143 703
Total	128 689 069	25 737 814

Source: Department of Agriculture, Fisheries and Forestry 2007

It is assumed that changes to fruit fly management and R&D structures proposed in the Action Plan will yield an average reduction in costs of 14 per cent to 18 per cent for the low and high scenarios, respectively. These figures are based on adjusted Plant Health Australia (2009) assumptions.

Savings from improved emergency response arrangements

The Action Plan targets improved emergency response arrangements to reduce the risk of fruit fly incursions (NFFSIC 2010). Reviewing national standards and making improvements to surveillance, diagnostics and emergency response arrangements aims to reduce the costs of responses to fruit fly incursions by exotic and endemic species (PHA 2009).

The expected annual cost of eradicating exotic incursions was estimated by Plant Health Australia at $13.3 million (PHA 2009). This figure is reached by estimating the likelihood of an incursion and multiplying it by the cost of eradication. Over the past 14 years, Australia has experienced three exotic fruit fly incursions, suggesting that the annual likelihood of incursion is 21 per cent. Estimates of potential savings from outbreaks of endemic fruit flies in pest-free areas are based on current spending on endemic eradication by state governments (Table 7).

Table 7 Average annual costs of eradicating Australian fruit flies from pest free areas

State	Average annual cost ($m)
Western Australia	0
South Australia	1.7
Victoria	5.5
New South Wales	1.4
Tasmania	0.4
Total	8.64

Source: Plant Health Australia 2009, updated with data from state governments, where available

It is assumed the Action Plan could reduce current expenditure on emergency response arrangements by between 14 per cent and 18 per cent for the low and high scenarios, respectively. These estimates are based on ABARES adjustment to assumptions used in the 2009 Plant Health Australia report.

This may be a conservative estimate, since more effective emergency response arrangements in the past have significantly reduced the costs of eradicating exotic fruit fly incursions. For example, in the mid–1990s the cost of eradicating Philippine fruit fly in Darwin was estimated at $7 million, compared with an estimated $35 million for papaya fruit fly incursion in Cairns. The difference in costs in these two examples is largely due to early detection of the Philippine fruit fly incursion through the use of effective trapping.

Other benefits

The Action Plan has the potential to deliver spillover benefits by reducing the impact of fruit flies on commercial horticulture production in Australia. These benefits are difficult to quantify and are more than likely to accrue to certain individuals and businesses rather than to society in general.

Benefits to backyard growers

Reducing the risk of exotic and endemic fruit fly outbreaks in commercial horticulture operations could benefit nearby backyard growers of fruit fly susceptible products. Benefits may include a reduction in direct crop losses to fruit flies and, if backyard growers use pest controls, a reduction in spraying costs. Measuring these spillover benefits is difficult because it is hard to estimate the size and value of backyard production, the marginal effect of the Action Plan on production, or the amount that backyard growers would be willing to pay to obtain these benefits.

Previous studies have tried to estimate the value of backyard fruit production in certain locations and extrapolated this result to estimate the value of lost backyard fruit production from fruit fly (Ha et al. 2010). Van Velsen (1987) estimated the annual value of backyard fruit production in Adelaide at over $22 million (equivalent to $45 million in 2010–11). In the absence of a fruit fly eradication program the study found 80 per cent of this value would be lost. Using van Velsen's methodology, the Horticultural Policy Council (1991) extrapolated the effect of endemic fruit fly to include Perth, Sydney and Brisbane. The value of lost backyard fruit production from fruit fly was estimated to be around $100 million (equivalent to $205 million in 2010–11).

However, as highlighted by PricewaterhouseCoopers (2001) and Ha and colleagues (2010), extrapolating the value of backyard production for the whole of Australia can be problematic. First, the value of fruit produce is not homogenous across landowners. The intrinsic value of knowledge of where the fruit has been grown may lead some individuals to place a higher value on their own produce compared with commercial produce, while other backyard growers may not assign much value to their fruit. Sales of fruit trees at nurseries suggest that some value is placed on ownership of fruit fly susceptible fruit trees (Access Economics 2010). However, it is not clear whether buyers value the fruit, blossom, shade or other attributes.

Second, the average number of trees used by van Velsen (1987) was based on observations in an older suburb of Adelaide, where fruit trees are common. The recent trend of smaller house blocks and larger dwellings means there is less room for gardens and fruit trees (PWC 2001). During eradication of fruit fly from the inner Melbourne suburb of Ascot Value in 2008–09 it was found that each household averaged 2.9 fruit trees (Ha et al. 2010), 30 per cent fewer than reported by van Velsen (1987).

Flow-on benefits

The horticulture industry links or interacts with other sectors of the economy through the demand for farm inputs and the supply of horticultural products. This means that the Action Plan has potential to provide flow-on benefits to other Australian industries in the form of increased marketable fruit fly susceptible horticulture production.

The 2007–08 input–output tables (ABS 2011) show the Australian horticulture industry is linked on the supply side to the fertiliser and chemical industry, transport industry, transport fuel industry and agricultural services. On the demand side, the horticulture industry is linked to

the food processors, wine and spirit industry, food retail industry and restaurants. It would be expected that any spillover effects of increased marketable fruit fly susceptible horticulture production would indirectly benefit these industries, to varying degrees.

These industries are interlinked with other sectors in the economy. However, increased marketable fruit fly susceptible horticulture production may not by itself generate sizable wider economic flow-on effects. The effect of a change in economic activity in any one industry on other sectors will depend on the scope and strength of the linkages, the size of the industry and the magnitude of the change in economic activity. The Action Plan is estimated to generate an additional $38 million annually for the high scenario, compared with an estimated annual gross value of fruit fly susceptible horticulture production of $5.3 billion; these figures suggest flow-on effects of the Action Plan to the wider economy would be relatively small.

5 Results

Estimated annual savings (or benefits) resulting from the Action Plan, based on parameter assumptions (Table 4), are set out in Table 8. Benefits are estimated at $29 million a year for the low scenario and $37.5 million a year for the high scenario. The average annual value of fruit fly susceptible horticulture production in Australia is approximately $5.3 billion.

The largest gains from the Action Plan are expected to be:

- reduced production losses
- savings from improved operational management
- savings from improved market access.

Main factors driving these results are:

- projected reductions in production losses (more than double the percentage change for other categories)
- lower expenditure on operational activities
- increased value of market access.

Table 8 Estimated annual benefits of Action Plan

Source of benefits	Low scenario ($m)	High scenario ($m)
Improved market access	5.7	7.3
Improved operational management practices	8.9	11.5
Reduced production losses	9.3	11.9
Enhanced management structures, research and development, extension and training	3.6	4.6
Improved emergency response capability	1.6	2.1
Total	29.2	37.5

Source: ABARES

Over the 20-year implementation of the Action Plan, the present value of these annual benefits is estimated at between $286 million and $367 million for the low and high scenarios, respectively (in 2011–12 dollars). With the present value of the cost of investment in the Action Plan at $23.5 million, net present value of investment in the Action Plan is estimated to range from $262 million to $344 million, with corresponding benefit–cost ratios of 12.1:1 and 15.6:1 (Table 9). This suggests each dollar invested in the Action Plan would generate on average between $12 and $16 in savings.

Table 9 Estimated benefits of Action Plan implementation

		Action Plan a		NFFS b
		Low scenario a	High scenario a	7% discount rate
Gross benefit	$m	286	367	415
Cost	$m	23.5	23.5	50
Net present value	$m	262.2	343.8	365
Benefit–cost ratio		12.1:1	15.6:1	8.3:1

a ABARES 2012. b Plant Health Australia 2009 report on the draft National Fruit Fly Strategy.

For the wider National Fruit Fly Strategy, the estimated net present value of the Action Plan is smaller than that estimated by Plant Health Australia (2009), while the benefit–cost ratio is larger (Table 9). This is consistent with the principle of diminishing marginal return from an investment that is assumed to apply to the benefits estimated for the low and high scenarios (Appendix C).

Sensitivity analysis

The effect of varying the main parameter assumptions on the three main drivers of benefits—production loss, market access and operational management costs—is explored using six sensitivity scenarios (Table 10):

1) Lower production losses from fruit fly in endemic areas—production losses in endemic areas reduced to a low effect (0 to 1 per cent loss) in this scenario, rather than a medium effect of fruit fly (0.5 to 3 per cent losses) (PHA 2009).

2) No production losses in fruit fly endemic regions—as assumed by Ha (2010), no or minimal production losses expected to occur with efficient on-farm control in this scenario, rather than a production loss of 28 and 36 per cent for the low and high scenarios, respectively.

3) Doubling the pre and post-harvest costs—pre and post-harvest cost increased to $538 a hectare and $125 a tonne, respectively, rather than $269 a hectare and $62 a tonne.

In contrast to the 20 per cent premium applied in the scenarios of the ABARES study:

4) Halving the market access premium—a market access premium of 10 per cent used.

5) Market access premium does not apply.

6) Doubling of the market access premium.

Table 10 Results of benefits sensitivity to changes in key parameters

	Sensitivity scenario	Low scenario Benefit ($m)	Low scenario NPV ($m)	Low scenario BCR	High scenario Benefit ($m)	High scenario NPV ($m)	High scenario BCR
1	Lower production losses from fruit fly in endemic areas	230.9	207.4	9.8	296.9	273.4	12.6
2	No production losses from fruit fly	194.5	171.0	8.3	250.1	226.5	10.6
3	Doubling pre and post-harvest costs	358.6	335.1	15.2	461.1	437.5	19.6
4	Halving of market access premium	257.8	234.3	11.0	331.5	308.0	14.1
5	No market access premium	229.9	206.4	9.8	295.6	272.1	12.6
6	Doubling market access premium	341.4	317.9	14.5	439.0	415.5	18.7
	ABARES study assumptions	285.7	262.2	12.1	367.3	343.8	15.6

BCR = benefit–cost ratio; NPV = net present value

Source: ABARES

Results from the sensitivity analysis show that, even with variations to the underlying parameters, significant gains are estimated for investing in the Action Plan. Sensitivity analysis is useful where underlying factors have changed and consequences are unknown; for example the effect on expected benefits from ongoing collaborative efforts between industry and governments in R&D and community awareness, or the suspension of dimethoate for treatment of selected produce in October 2011.

Future benefits and costs in this study were discounted with a 7 per cent discount rate to account for the time preference of money. This rate was chosen based on advice from the Office of Best Practice Regulation of the Department of Finance and Deregulation (Australian Government 2010). The effect on the estimated benefits and costs of a 1 percentage point change around the 7 per cent discount rate was measured (Table 11). This sensitivity analysis found that a 1 percentage point change in the discount rate (equivalent to a 14 per cent change) could result in a 6 per cent change in the net present value of the Action Plan.

Table 11 Results of benefits sensitivity to different discount rates

	Low scenario			High scenario		
Discount rate (%)	**6**	**7**	**8**	**6**	**7**	**8**
Present value of benefits ($m)	309.5	285.7	264.5	397.9	367.3	340.1
Present value of costs ($m)	23.9	23.5	23.2	23.9	23.5	23.2
Net present value ($m)	285.6	262.2	241.4	374.0	343.8	316.9
BCR	12.9	12.1	11.4	16.6	15.6	14.7

Finally, the effect of increasing annual project costs beyond the third year was examined. Ongoing annual costs were assumed to be 10 per cent of the expenditure in the third year for each project. Under this assumption, the cost of implementing Action Plan projects would rise by $3.5 million in present value terms (18 per cent). Net present value of the Action Plan would decline to between $258.7 million and $340.3 million, and the benefit–cost ratio to 10.6 and 13.6 for the low and high scenarios, respectively. If ongoing costs of implementing Action Plan projects were significant, the original assumptions would overestimate net benefits of the plan.

Distribution of benefits from the Action Plan

The Action Plan is designed to generate savings to all stakeholders who currently invest in fruit fly management strategies. Federal and state governments provide funding for fruit fly management, particularly surveillance, eradication, regulation and R&D. Industry also contributes funding to R&D projects, management initiatives and emergency response, as well as contributing at a grower level through compliance with regulations and on-farm management to suppress pest prevalence. The distribution of quantified benefits from these investments is examined across these stakeholders.

Benefits to stakeholders

Estimated national benefits from the Action Plan can be apportioned to the three main beneficiaries—industry, the Australian Government, and state and territory governments—based on the likely recipients of benefits or cost savings.

The horticulture industry includes producers and exporters of fruit fly susceptible produce. This industry is assumed to receive the benefits from avoided production loss and gains in export value from improved international market access (Figure 5). It is also assumed that industry will benefit from avoided operational costs for pre and post-harvest treatments.

Savings in management and R&D are expected to be shared by all parties, with industry benefiting from R&D savings (R Turner, PHA 2012, pers. comm.), which make up 18 per cent of the management savings (DAFF 2007); the remainder will flow to the states and federal governments equally. Similarly, savings in the eradication of exotic fruit fly are expected to flow in proportion to the cost-sharing agreement of the *Emergency Plant Pest Response Deed*, with 20 per cent funded by industry and 80 per cent funded equally by governments in the case of a Category 2 pest exotic fruit fly (PHA 2011).

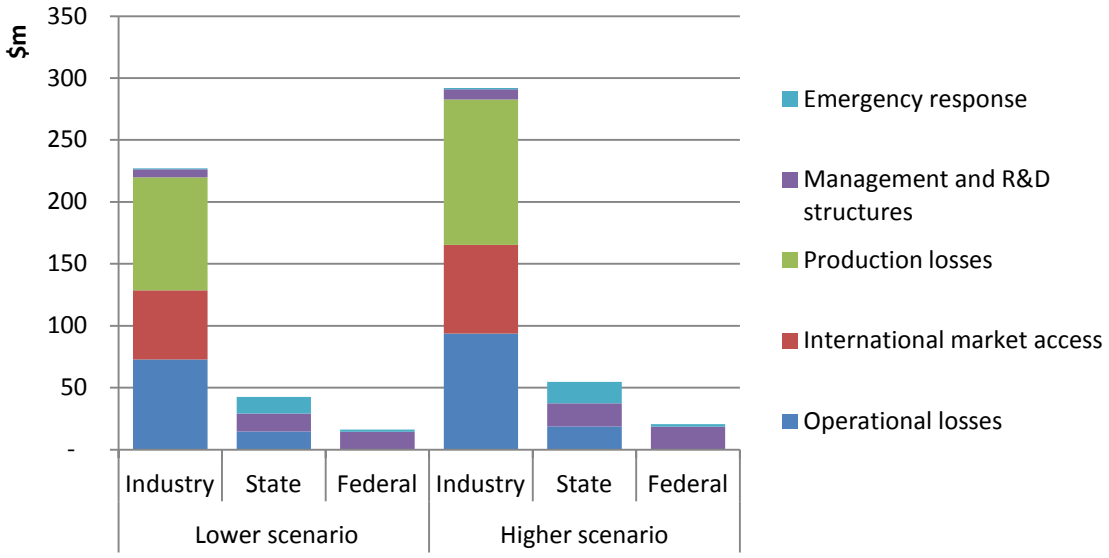
State and territory governments are expected to benefit from reduced operational costs of maintaining pest-free areas and eradicating endemic fruit fly.

Based on these broad assumptions, it is estimated that the Action Plan gross benefits (or savings) for the low and high scenarios, respectively would be shared as follows over the 20-year implementation period:

- $227 million to $292 million to fruit fly susceptible industries from avoided production losses, savings in pre and post-harvest treatment and gains in export value through improved market access
- $43 million to $55 million to state and territory governments from reduced operational costs of maintaining pest-free areas, reduced costs for emergency response and management, and more cost-effective R&D
- $16 million to $21 million to the Australian Government from reduced costs for emergency response and management, and more cost-effective R&D.

It should be noted that these values represent the estimated shares of the aggregate gross benefit from the Action Plan accruing to these parties. The potential size of any investment in the Action Plan made by each party is not taken into account.

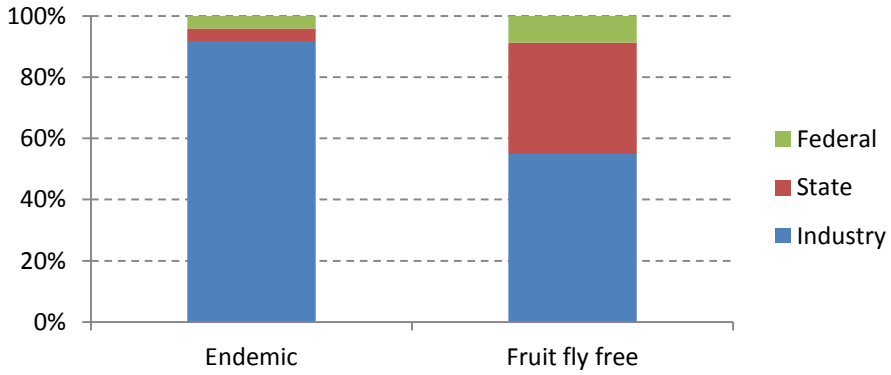
Figure 5 Estimated gross benefits for stakeholders from implementation of Action Plan



Source: ABARES

To some extent the distribution of benefits between these three stakeholders reflects the historical management of fruit fly. Limited government involvement in the management of fruit fly in endemic areas results in a small benefit to government (Figure 6). By contrast, in fruit fly free areas, where governments fund fruit fly management a greater proportion of benefits are expected to flow to governments.

Figure 6 Proportion of benefits to stakeholders in fruit fly free and endemic regions



Source: ABARES

6 Governance Body

The Implementation Committee endorsed a recommendation from the 2008 draft National Fruit Fly Strategy to appoint an ongoing management structure to oversee the Action Plan. The committee proposed an independent National Fruit Fly Governance Body to deliver a cooperative program involving the Australian horticulture industry and governments. Experts on both the National Fruit Fly Strategy Panel and Implementation Committee consider the Governance Body essential to the successful implementation of a national strategy plan for fruit fly management. The Implementation Committee proposed that Plant Health Australia assume the functions of national governance body (NFFSIC 2010).

The Implementation Committee believes that the aim of the proposed Governance Body is to oversee the strategy and realise its goals of improving national management of fruit flies in Australia, particularly through the implementation of the projects outlined in the Action Plan. Responsibilities of the Governance Body include driving and measuring the implementation process, analysing the fruit fly management system and proposing relevant measures to address concerns as they arise. It would also be responsible for overseeing the provision of fruit fly information and the prioritisation of fruit fly R&D. Two models have been proposed by Plant Health Australia:

- Governance Body–Model A: Plant Health Australia establishes an in-house program to maintain full-time oversight of the national management of fruit flies, liaise with different groups, drive the delivery of Action Plan projects and provide half-yearly reports to members. The Governance Body would be skills-based, reflect the interests of stakeholders and likely to generate greater gains than the management structure proposed in Model B. The value of program costs over 20 years is estimated at about $3.9 million (in 2011–12 dollars).

- Governance Body–Model B: Plant Health Australia oversees implementation of the National Fruit Fly Strategy and provides reviews as appropriate. The estimated net value of costs for this option is $1.7 million (in 2011–12 dollars).

Potential benefits or cost savings that could be generated by the proposed management structure are summarised in Box 3.

Box 3 Potential benefits of the National Fruit Fly Governance Body

Economies of scope for reducing costs A coordinated national response to fruit fly is most effective where the overall cost of the service can be reduced; this is because there are economies of scope. A governance body can help reduce overlap of functions and duplication of services, such as R&D, information technology systems and technical information (DPI 2005). For example, it would be costly for each susceptible horticulture industry (citrus, pome, stone) to separately develop and maintain databases and diagnostic standards.

Emergency response capability In some instances, a governance body will make marshalling legislation and regulations for resources easier and more rapid, such as in emergency situations for established species. A quick response reduces the spread of the disease and its potential damage, lowers the cost of eliminating threats, increases the probability of success of response and minimises disruption to trade. Further, a governance body can help to ensure that individuals take actions not only in the private interest of individual growers but also for the common good (DPI 2005).

International and national obligations The proposed structure of governance would help ensure nationally consistent legislation and regulation. In a trading environment that places increasing emphasis on phytosanitary measures, and where sustainability of many industries depends on market access, a national framework is of increasing importance (PHA 2008). National coordination of research and legislation would be of significant potential benefit in terms of maintaining or increasing future accessibility to different markets.

Assessing the economic feasibility of a governance body

For a governance body to be economically feasible the benefits it generates need to outweigh the cost of its establishment and operation. However, it is difficult to isolate and precisely quantify the benefits of establishing a National Fruit Fly Governance Body in this study because the benefits of any new management mechanism are subsumed within the overall benefits expected to accrue from the Action Plan. It is not possible to make a real-world comparison between the benefits of having a governance body oversee the Action Plan with the benefits that might arise in the absence of a governance body.

To overcome this constraint, a threshold analysis approach is used. The threshold analysis can provide an indicator of the economic feasibility of a proposal, a threshold benchmark. Such a benchmark can help decision-makers compare the return of investing in a governance body with the likely loss of benefit from not having a governance body.

Results in Table 12 suggest that only a slight loss in benefits (1.5 per cent) in implementing the Action Plan would justify the establishment of Governance Body–Model A, if there is a certainty that benefits will be reduced without such a body. That is, if the Action Plan failed to generate 1.5 per cent of the expected benefits ($262 million in 2011–12 dollars) for the low scenario, and this could be redressed with a governance body in place, the benefits gained would cover the cost of establishing and operating the body.

Table 12 Governance Body investment thresholds

	Probability of inefficient implementation without Governance Body (%)	Efficiency threshold (%)	
		Governance Body–Model A ($3.9m)	Governance Body–Model B ($1.7m)
Low scenario	100	1.5	0.6
	50	3	1.2
High scenario	100	1.2	0.5
	50	2.4	1

Source: ABARES

For example, if there were a 100 per cent probability that the Action Plan could not be implemented efficiently, and that the expected net benefits would decline by more than 1.5 per cent without a governance body, then a decision-maker might choose to invest in Governance Body–Model A. Alternatively, if the probability were 50 per cent, it would require more than a 3 per cent reduction in benefits to justify establishment of a governance body. Lower threshold estimates would apply if Model B were established (Table 12). However, if the probability of inefficient implementation without a governance body were considered to be less than 50 per cent, higher threshold estimates would apply.

Appendix A: Summary of National Fruit Fly Strategy Action Plan projects

Descriptions of projects taken from National Fruit Fly Strategy Action Plan (NFFSIC 2010).

Project 1 National data sheets for high priority species

Develop species specific data sets for all exotic and endemic high priority species (identified through Project 2). Building on existing data sheets:

- process all fruit fly data into the agreed datasheet format before undertaking a gap analysis to identify potential areas where further work is required
- improve, validate and publish data results
- store all information in an appropriate electronic format, such as the Australian Biosecurity Intelligence Network or the Pest and Disease Image Library.

Project 2 National biosecurity plan for fruit flies

Develop a national biosecurity plan for fruit flies that will include:

- risk analysis of all endemic and exotic fruit flies that could affect Australian horticultural industries
- biological and ecological data on all high priority species (see Project 1)
- diagnostic protocols (see Project 3) and contingency plans for high priority species
- relevant preparedness and prevention measures, such as on-farm biosecurity practices
- surveillance and detection strategies (see projects 4 and 5)
- technical management information, such as chemical usage.

Use the biosecurity plan as the basis for preparedness activities, including the development of:

- specific fruit fly biosecurity surveillance
- Biosecurity Surveillance Incident Response and Tracing system templates
- incursion simulation training packages that can be used by stakeholders, as required.

Project 3 National fruit fly diagnostic standards and networks

Establish a nationally agreed standard for fruit fly diagnosis by:

- building on existing work in this area, establishing and maintaining a national diagnostics network
- identifying, through the network, national and international experts, laboratories and centres of expertise, essential equipment and reference collections
- providing the necessary tools to promote communication and collaboration.

Project 4 Mapping Australia's fruit fly status

The mapping process will:

- ensure all fruit fly surveillance programs are captured in the Biosecurity Surveillance Incident Response and Tracing system and, where possible, past data
- assist in the establishment of a national map of surveillance activities capable of presenting the status of all high priority species in real time.

Project 5 Integrated national fruit fly surveillance system

Integrating surveillance will involve:

- reviewing current fruit fly surveillance practices against domestic and international standards, particularly surveillance techniques, trapping tools and data interpretation methods
- using the data to compile national standards for fruit fly surveillance that meet market access requirements, including export certification, early detection and emergency response outcomes.

Project 6 Maintain the Torres Strait Fruit Fly Detection and Eradication Program

The program combines routine early detection surveillance with eradication activities aimed at preventing the entry and establishment, on the Australian mainland, of several target economic fruit flies. Maintaining the program will include:

- providing long-term support
- reviewing the current area of operation and high risk entry points to ensure the program continues to effectively protect Australia against fruit fly threats from South-East Asia
- conducting a comprehensive benefit–cost analysis of the program, aligning program delivery and funding with other detection and eradication programs and securing ongoing funding through an agreed cost-sharing arrangement.

Project 7 National fruit fly information portal

This project will involve:

- developing a portal to provide access to all relevant fruit fly information and a networked work space for communication and collaboration.
- creating a database containing information about implementation of the strategy, including diagnostic protocols, treatment schedules, pest data sets and national standards.

Project 8 National standards for fruit fly disinfestation treatments

This project will involve:

- studying the range of post-harvest disinfestations treatments in order to meet current and foreshadowed market access requirements
- using this study to recommend further research into current and new measures
- documenting these measures as an Australian disinfestation treatment schedule for fruit fly and securing its national endorsement.

Project 9 National standards for fruit fly management systems

This project will involve:

- reviewing current field control and pre-harvest treatment measures for fruit fly to provide options for effective management and control of fruit fly across a wide range of situations and outcomes, for example area-wide management
- using the review to develop efficacy or outcome standards for national agreement and implementation
- commissioning a review of current sterile insect technique (SIT) practices to develop a national position on the use of SIT for managing fruit flies in Australia
- incorporating within the review the range of activities associated with production and dispersal of flies and aligning recommendations with international best practice
- developing measures to manage abandoned orchards, thereby reducing fruit fly breeding areas.

Project 10 Development and adoption of systems approaches for market access

Support current activities focused on the application of a system approach for fruit fly management that will increase market access.

Building on this project, develop three specific models for fruit fly to test the system approach framework proposed by the Australian Centre of Excellence for Risk Analysis. These models will case study:

- citrus from Central Burnett for the replacement of dimethoate and fenthion
- tomatoes/capsicum from Bowen for the replacement of dimethoate and fenthion
- produce from south-east Australia under temporary pest-free areas (PFA), areas of low pest prevalence (ALPP) and possibly pest-free places of production PFPPs (see Project 11).

Document within these models:

- expected efficacy of the system
- realistic pathways to adoption
- time frames for acceptance by domestic markets.

Using these models as the basis, a workshop will be held to gain agreement on a standardised approach to the analysis, endorsement and application of a systems approach to fruit fly management.

Project 11 National approach to PFA, ALPP and PFPP for market access

This project will involve:

- using international standards to enhance and document national standards for managing fruit flies in pest-free areas (PFAs), areas of low pest prevalence (ALPP), pest-free places of production (PFPP) and pest-free production sites (PS)

- finalising revised codes of practice for the establishment of area freedom from Medfly and Qfly
- developing regional guidelines for operations, promoting consistent management measures within biogeographical regions of equivalent risk profile
- developing a national verification model for fruit fly free areas to ensure domestic certification complies with international phytosanitary certification
- drawing on the national standards and the national verification model, develop management strategies for specific regional areas.

Project 12 Harmonisation of fruit fly interstate certification arrangements

This project will involve harmonisation of all domestic fruit fly interstate certification assurances, taking into account international standards, national standards and pest risk analysis.

Project 13 Provision of market access information

Government and industry stakeholders need access to phytosanitary requirements for horticultural produce destined for both domestic and international markets. This project will provide this information and increase awareness of market access processes by consolidating, documenting and presenting to all stakeholders:

- steps and processes involved in gaining and maintaining market access
- roles and responsibilities of key stakeholders in gaining and maintaining market access
- risk analysis processes.

Project 14 Fruit fly R&D priorities

Generate a fruit fly research priority guide on a regular basis, using information gathered from:

- review of market access requirements (see Project 13)
- gap analysis of the production supply chain
- outputs from each of the projects identified in this plan.

Integrate this prioritisation process with the proposed Primary Industries Standing Committee R&D agenda and use it to inform priorities for research providers, including Horticulture Australia Ltd.

Project 15 Coordinated national fruit fly awareness/communications

Coordinate current efforts around Australia to raise awareness of the effects of fruit flies and encourage attitudinal and behavioural change in fruit fly management by:

- developing a national communication strategy to analyse current awareness levels
- identifying possible synergies between agencies
- proposing communication messages delivered in collaboration with a central coordinating agency.

Appendix B: Statistical divisions managed for fruit fly free status

Table B1 Statistical divisions managed for fruit fly free status

State	Statistical division
New South Wales	Murrumbidgee
	Murray
Victoria	Melbourne
	Barwon
	Western District
	Central Highlands
	Wimmera
	Mallee
	Loddon
	Goulburn
	Gippsland
South Australia	Adelaide
	Outer Adelaide
	Yorke and Lower North
	Murray Lands
	South East
	Eyre
	Northern
Tasmania	Greater Hobart
	Southern
	Northern
	Mersey–Lyell

Note: Due to outbreaks of fruit fly, a region may not be recognised as fruit fly free for domestic or international trade purposes.

Source: ABARES

Appendix C: Theoretical framework for examining returns from Action Plan

The theoretical framework used to examine benefits of the Action Plan is underpinned by assumptions about investment behaviour in fruit fly management activities:

- Investment in fruit fly management follows the principle of diminishing marginal returns. That is, the return from each additional unit of investment decreases, since additional investments are made in increasingly less profitable activities.
- Marginal returns diminish at a constant rate.
- The 2008 draft National Fruit Fly Strategy represented the optimal allocation of resources, where the maximum net benefit is obtained through implementation of the draft strategy in its entirety. That is, the additional benefit obtained from the last unit that would have been invested in the wider National Fruit Fly Strategy is equivalent to the value of investment; for example, the last dollar invested in control would generate a total benefit from all sources of exactly one dollar.
- The Action Plan is a subset of strategies contained in the draft strategy. As a result of the prioritisation process, projects that provide the highest returns were selected first for investment.

These assumptions about the draft National Fruit Fly Strategy, together with estimates from the benefit–cost analysis of the strategy, were used to develop a spreadsheet model to estimate the benefits from investment in the Action Plan. The model generates the same path for the costs and benefits of investment in the Action Plan as that for the broader draft strategy. Therefore, given the lower proposed investment in the Action Plan, the benefit is calculated from the initial marginal benefit and the constant rate of decline in marginal benefits up to an investment of $23 million (proposed cost of Action Plan) (Figure C1).

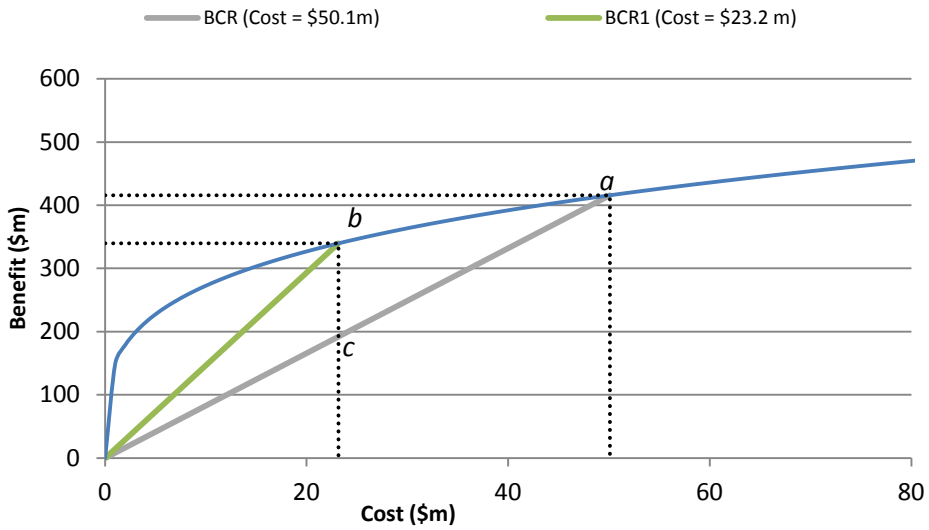
Given that higher returning activities are selected first for investment in the Action Plan, it is expected that the average return per dollar invested would be higher than that obtained from investing in the draft National Fruit Fly Strategy. The *a priori* expectations from this analysis suggest that the net present value (NPV) resulting from the Action Plan would be lower and the benefit–cost ratio higher, in comparison with those estimated under the benefit–cost analysis of the 2008 draft strategy.

Based on this framework, it is estimated that a 53 per cent reduction in investment, compared with the broader draft National Fruit Fly Strategy, corresponds to a reduction in gross benefits of 17.9 per cent. In Figure C1, this is depicted as a movement along the gross benefit curve from point *a* to point *b*, where it is assumed that diminishing marginal returns from investment holds.

If $23 million is invested in the Action Plan, this suggests it could result in a total gross benefit of almost $341 million, or 18 per cent less than gross benefits estimated by Plant Health Australia (2009), providing an NPV of $318 million and a benefit–cost ratio of 14.6:1. The estimated gross benefit is within the range of estimated benefits under the low and high benefit scenarios.

Note that in this framework the percentage declines in benefits depend on the percentage decline in the cost of the Action Plan, relative to that of the 2008 draft National Fruit Fly Strategy.

Figure C1 Estimated gross benefits–Action Plan versus National Fruit Fly Strategy



BCR = benefit–cost ratio

Source: ABARES

References

ABARE 2005, *Socioeconomic value of a collaborative approach to biosecurity in Australia*, Australian Bureau of Agricultural and Resource Economics, report to Product Integrity Animal and Plant Health Division, Canberra, August.

Access Economics 2010, *Funding of a Queensland fruit fly (QFF) management program in Victoria*, Access Economics, report for Queensland Department of Primary Industries, April.

ABIN 2011*, Fruit-fly-body-knowledge*, Australian Biosecurity Intelligence Network, available at abin.org.au/web/communities/fruit-fly-body-knowledge/, viewed 10 October 2011.

ABS 2011, *Australian National Accounts: Input–Output tables*, cat. no. 5209.0.55.001, Australian Bureau of Statistics, Canberra, available at abs.gov.au/AusStats/ABS@.nsf/MF/5209.0.55.001.

ABS 2010a, *Australian commodities: Small area data,* cat. no. 7125.0, Australian Bureau of Statistics, Canberra.

ABS 2010b, *Value of principal agricultural commodities*, cat. no. 7503.0, Australian Bureau of Statistics, Canberra. Data accessed for 2006–07, 2007–08, and 2008–09.

Australian Government 2010, *Australian Government 2010, Best Practice Regulation Handbook*, Office of Best Practice Regulation of the Department of Finance and Deregulation, Canberra, available at finance.gov.au/obpr/proposal/gov-requirements.html.

Beale, R, Fairbrother, J, Inglis, A & Trebeck, D 2008, *One biosecurity: A working partnership*, *The independent review of Australia's quarantine and biosecurity arrangements report to the Australian Government*, Commonwealth of Australia, Canberra, September.

Biosecurity SA 2012, *Fruit fly,* Plant Health, Department of Primary Industries and Regions South Australia, available at pir.sa.gov.au/biosecuritysa/planthealth/fruit_fly, last updated 3 January 2012.

DAFF 2010, *Fruit Fly Code of Practice*, document prepared for Working Group workshop 22 October 2010 (Sydney), Department of Agriculture, Fisheries and Forestry, Canberra.

DAFF 2009, 'Pests of plants: Exotic fruit flies', Northern Australia Quarantine Strategy fact sheet, Department of Agriculture, Fisheries and Forestry, Canberra, available at daff.gov.au/aqis/quarantine/naqs/naqs-fact-sheets/fruit-flies, viewed 25 November 2011.

DAFF 2007, *Australian fruit fly activities stocktake 1 July 2003 to 30 June 2008*, Office of the Chief Plant Protection Officer, Department of Agriculture, Fisheries and Forestry, Canberra, available at daff.gov.au/animal-plant-health/plant/publications/national_fruit_fly-related_activities_stocktake_2003-08, last updated on 19 January 2007.

Dominiak, BC & Daniels, D 2011, 'Review of the past and present distribution of Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) and Queensland fruit fly *Bactrocera tryoni* (Froggatt) in Australia', *Australian Journal of Entomology,* 21 December 2011.

DPI 2005, *Review of plant health*, Evaluation report no. 9, August, Department of Primary Industries, Melbourne, Victoria.

DPIPWE 2011, *Review of import requirements for fruit fly host produce from mainland Australia*, Biosecurity Technical Group, Department of Primary Industries, Parks, Water and Environment, Davenport, Tasmania, available at dpiw.tas.gov.au/inter.nsf/Attachments/LBUN-8KZ8B3/$FILE/Fruit%20Fly%20IRA%20DRAFT%20CONSULT.pdf (pdf 787.27kb).

Fraser, G 2011, *Plant biosecurity in Australia–A powerful government–industry partnership*, presentation by Plant Health Australia, available at planthealthaustralia.com.au/go/phau/our-company/our-documents/conference-papers.

Goodwin, S 2012, 'Dimethoate ban sparks fruit fly fear', *Weekly Times*, 12 October 2011.

Ha, A, Larson, K, Harvey, S, Fisher, W & Malcolm, L 2010, *Benefit–cost analysis of options for managing Queensland fruit fly in Victoria*, Evaluation report, no. 11, April, Department of Primary Industries, Melbourne, Victoria.

Harvey, S & Fisher, B, Larson, K & Malcolm, B 2010, *A benefit cost analysis on management strategies for Queensland fruit fly: Methods and observations*, Australian Agricultural and Resource Economics Society Conference, Melbourne, available at ageconsearch.umn.edu/bitstream/59740/2/Harvey percent2c percent20Sallyann.pdf (pdf 1.18mb).

Horticultural Policy Council 1991, *The impact of fruit flies on Australian horticulture*, report to the Honourable John Kerin, Minister for Primary Industries and Energy, Horticultural Policy Council Industry report no. 3, Canberra, April.

Kalang Consultancy Services 2008, *Review of fruit fly management in Victoria and options for future management*, independent review for Department of Primary Industries, Melbourne, Victoria.

Macarthur Consulting 1998, *Review and management strategy for fruit fly research and development in the field*, final report, Horticultural Research and Development Council project CT97024, Sydney, New South Wales.

NFFSIC 2010, *National Fruit Fly Strategy: Implementation Action Plan*, National Fruit Fly Strategy Implementation Committee, Canberra, April.

PHA 2008, *Draft National Fruit Fly Strategy,* commissioned by the Primary Industries Health Committee and prepared in collaboration with the Australian Government, state and territory governments, plant industries and the research community, Plant Health Australia, Canberra, March.

PHA 2009, *Economic assessment of the implementation of the proposed National Fruit Fly Strategy: Part 1*, Plant Health Australia, August, Canberra.

PHA 2011*, Government and Plant Industry Cost Sharing Deed in respect of Emergency Plant Pest Responses*, available at planthealthaustralia.com.au/index.cfm?objectid=4C790280-C417-4E27-91273F50ABAE3A24.

PricewaterhouseCoopers 2001, *Benefit cost analysis of the Tri-State Fruit Fly Strategy,* report to the Department of Agriculture, Fisheries and Forestry, PricewaterhouseCoopers, Canberra.

Productivity Commission 2010, *Wheat export market arrangements*, report no. 51, July, Canberra.

Quarantine Domestic, 2012, *Destination: Victoria*, Domestic Quarantine Market Access Working Group, Melbourne, Victoria, available at quarantinedomestic.gov.au/destination-victoria.html.

Schotter A 2003, *Microeconomics: A modern approach*, 3rd edn, Prentice Hall, New Jersey, United States.

van Velsen, RJ 1987, 'Review of fruit fly campaigns', Department of Agriculture, South Australia. in Horticultural Policy Council, 1991.