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# Protecting Australia's horticultural industries from disease:

## The impacts of *Xylella fastidiosa* on Australian horticulture and the environment

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# Summary

Xylella is one of the world's most devastating plant pests and Australia's number one priority plant pest. It is a bacterium, primarily transmitted by insect hosts, that results in yield losses and plant deaths. Following its appearance in Europe, the Australian Government introduced emergency measures to reduce the likelihood of entry of *X. fastidiosa* in 2015. It also introduced post-border measures to prepare Australia in the event the pathogen and its vectors enter the country (Department of Agriculture and Water Resources 2015a, 2015b, 2016).

This report estimates the economic and environmental impacts of 4 subspecies of *Xylella fastidiosa* (*X. fastidiosa*) entering and establishing in Australia. The direct economic costs to 21 susceptible crops are estimated and the potential flow-on impacts on sectors dependent on their production are assessed qualitatively. The impacts on the nursery industry and the environment are also described.

The quantitative estimates of the potential costs to the cropping industry have been calculated over 50 years with a discount rate of 3% (see Box 1 for details). For any subsequent assessments of projects to mitigate the risk of Xylella it will be important to consider uncertainties around whether Xylella will enter and the effectiveness of mitigation projects.

## The cost to the cropping industry depends on the Xylella subspecies

The differences in host specificity between subspecies (*fastidiosa*, *pauca*, *multiplex* and unspecified) which could potentially enter and establish in Australia are the key drivers determining which susceptible plant species would be affected.

An incursion of a single subspecies is the most likely event. A single subspecies entering and establishing in Australia is estimated to cost the cropping industry between $1.2 billion and $8.9 billion in 2017–18 dollars over 50 years at a 3% discount rate (Table S1).

Table S1 Direct economic costs to horticultural crops by *X. fastidiosa* subspecies combination

| | | Annual spread rate | |
|---|---|---|---|
| **Relative likelihood** | **Subspecies combination** | **4%** | **10%** |
| | | 2017–18 $ billion[a] | |
| **Single subspecies** | *multiplex* | 1.2 | 1.8 |
| | *unspecified* | 1.5 | 2.1 |
| | *pauca* | 2.0 | 2.8 |
| | *fastidiosa* | 6.3 | 8.9 |
| **Two subspecies** (less likely than single subspecies events) | *pauca-multiplex* | 2.1 | 3.0 |
| | *multiplex-unspecified* | 2.6 | 3.7 |
| | *pauca-unspecified* | 3.3 | 4.8 |
| | *fastidiosa-pauca* | 6.4 | 9.1 |
| | *fastidiosa-multiplex* | 6.4 | 9.2 |
| | *fastidiosa-unspecified* | 7.7 | 11.0 |
| **Three subspecies** (less likely than two subspecies events) | *pauca-multiplex- unspecified* | 3.4 | 4.9 |
| | *fastidiosa-pauca-multiplex* | 6.4 | 9.2 |
| | *fastidiosa-pauca- unspecified* | 7.7 | 11.0 |
| | *fastidiosa-multiplex- unspecified* | 7.8 | 11.1 |

**a** In present value terms estimated over 50 years at a 3% discount rate.

It should be noted that there is uncertainty about the magnitude of the (undiscounted) farm level impacts. Given the number of crops involved, this study has used a pragmatic approach to estimating these costs. For detailed project appraisal it would likely be useful to understand the range of potential impacts through more detailed analysis of alternative investment choices or through additional sensitivity analysis.

When more than one subspecies enters and establishes in Australia, the estimated economic cost increases with the number of crops affected. However, the likelihood of multiple incursion events progressively decreases as the number of subspecies included increases. For example, an event with 2 subspecies is more likely than an event with 3 subspecies. A 2-subspecies incursion event could increase the estimated cost up to a maximum of $11.0 billion (Table S1), depending on the 2 subspecies involved. It would take a 3-subspecies incursion event involving *fastidiosa*, *multiplex* and unspecified for all 21 susceptible crops to be affected, with an estimated cost of between $7.8 billion and $11.1 billion.

## Significant flow-on impacts from primary production losses

Flow-on impacts from production losses in susceptible cropping industries can be significant. Around quarter of the wholesale value of total Xylella-susceptible crop production (excluding wine grapes) was used by Australian fruit and nut processing industries in 2017–18.

Fresh agricultural produce accounts for 25% of the sale value of the processed fruits and vegetables (ABS 2019a). Of the other inputs used, labour accounts for 17%, wholesale trade 12%, other food products 11% and transport 5%. As use of imported fresh fruit as a substitute in the domestic processing is unlikely to be economically viable, any reduction in fresh fruit inputs going into processing because of Xylella damage is expected to reduce processing output, and therefore the derived demand for these other inputs, including labour. This could lead to reduced incomes for the labour used in fruit processing, and reduced revenue for the wholesale trade, other food products and transport industries. Impacts further along value chains, where processed product is used as an input to further processing, will be mitigated by the extent that imported products can substitute for domestically sourced intermediate inputs.

Wine grapes are the most valuable crop that could be affected by Xylella and it is therefore expected to generate the highest flow-on impact because all of its produce is processed into wine and viable options for importing wine grapes for processing in Australia are unlikely. Xylella was estimated to cost the Australian wine making industry between $7.2 billion and $10.3 billion at a 3% discount rate (converted from the estimate in Hafi et al. (2017) of between $3.7 and $5.3 billion in 2017–18 dollars over 50 years at a 7% discount rate). Flow-on impacts to downstream industries relying on other susceptible crops would also be expected but have not been estimated.

## Xylella could cost the nursery industry as well

If Xylella were to become endemic in Australia it could affect the nursery industry in two ways:

1) the costs and any revenue losses incurred in complying with movement restrictions imposed to slow the spread
2) any revenue losses from disease damage to plants and planting materials and damage mitigation costs.

## Environmental impacts are likely but uncertain

While Xylella can cause significant environmental impacts overseas, there is uncertainty about the likely extent of impacts on native plant species.

There is no evidence that Xylella has caused or is causing species extinction. In general, a more plausible scenario for Australia could be some tree kills across several species, resulting in a reduction in tree numbers and a weakening of the remaining disease-affected trees. These two effects could jointly contribute to a reduction in some ecosystem services.

In a contingency plan prepared for Xylella in Australia, the Queensland Department of Agriculture and Fisheries (QDAF 2016) rates the risk of environmental impacts to be lower than the risk of impacts on agricultural and amenity plants. While this conclusion appears reasonable given the international experience there is significant uncertainty.

# 1 Xylella fastidiosa

Xylella (*X. fastidiosa*) is a bacterium that disrupts water and nutrient flows in the xylem of plants, resulting in yield losses and tree deaths. It is transmitted by insect vectors, and by grafting infected scion onto healthy rootstocks. The pathogen and its known vectors overseas – such as the glassy-winged sharpshooter (GWSS) (*Homalodisca vitripennis*) and the blue-green sharpshooter (*Graphocephala atropunctata*) – are not present in Australia. But should the pathogen enter Australia, native sap-sucking insects, such as spittlebugs, could possibly assist in its spread.

According to the 2020 May update by the European Food Safety Authority (EFSA), *X. fastidiosa* is reported to be infecting over 595 plant species belonging to 264 genera and 82 families across the world (EPPO 2020). Globally, the threat of Xylella continues to increase, with the pathogen spreading further afield from its original habitat in North and South America and from more recent homes in southern Italy, France and Spain.

In Australia, there are strict quarantine measures implemented pre- and post-border to prevent the entry of the Xylella pathogen and its vectors. The Australian Department of Agriculture, Water and the Environment regulates 104 host plant families (342 genera and 736 species) under its Biosecurity Import Conditions (BICON), based on their susceptibility to Xylella and being hosts of its known vectors (Kevin Davis [DAWE] 2021, pers. comm., 7 September). With these measures in place, the likelihood of Xylella and GWSS entering Australia was rated at medium and low, respectively (QDAF 2016).

The differences in host specificity between subspecies (*fastidiosa*, *pauca*, *multiplex* and unspecified) which could potentially enter and establish in Australia are the key drivers determining which susceptible plant species would be affected. In addition to uncertainty around which *X. fastiodasa* subspecies would enter Australia, little is known about the suitability of different Australian habitats for the pathogen and its vectors, the rate the disease would spread across the landscape, the nature of the damage it would cause and to what extent it could be mitigated.

There have been two impact assessments on the potential establishment of Xylella in Australia, both focussing on wine grapes and the flow-on impacts. The first study by Monash University, which considers a worst-case scenario of the disease wiping out 80% of Barossa vineyards and spreading to the rest of South Australia, estimated cost of around $4.2 billion over 20 years (Wittwer et al. 2006). Hafi et al. (2017) estimated that if Xylella were to enter and establish in Australia, it could cost the Australian wine grape and wine-making industries between $2.8 billion and $7.9 billion in losses over 50 years (in 2015 dollars estimated using a 7% discount rate).

In the results reported here, the previous research on Xylella is extended by providing a comprehensive assessment of economic impacts covering all known susceptible crops, as well as describing the nursery industry and environmental assets that are under threat.

# 2 Far reaching impacts

## 2.1 Over twenty crops are under threat

Xylella-susceptible crops include high value horticultural crops grown in Australia. These crops include avocados, cherries, citrus (oranges, mandarins, lemons, limes, and grapefruits), grapes (dried, table and wine), nuts (almonds, macadamias, pecans, pistachios, and walnuts), olives and stone fruits (apricots, nectarines, peaches and plums). They are grown throughout the country, with a gross value of production (GVP) of around $4.7 billion in 2017–18 (ABS 2019a) and exports valued at $4.6 billion (FOB) (ABS 2019b). These crops contribute to around 9% of the Australia's total agricultural GVP (ABS 2020a).

## 2.2 Downstream industries could also be affected

Around quarter of total Xylella-susceptible crop production (excluding wine grapes) in Australia was used by processing industries in 2017–18. These industries provide employment opportunities and generate flow-on (or indirect) contributions to the Australian economy via linkages to other sectors of the economy. These other sectors include industries that supply other goods and services (inputs other than fresh fruits) used in fruit and nut processing, and those engaged in marketing processed fruits and nuts.

## 2.3 Nurseries are likely to have a significant role in an outbreak

Should Xylella enter Australia, it is very likely that the first infected property could be a nursery that has imported infected propagative materials, and subsequently distributed plants propagated from them to other nurseries. Nurseries are likely to be affected by costs incurred in complying with movement restrictions and phytosanitary requirements imposed following an outbreak, as well as costs from damaged products and actions taken to mitigate that damage.

The gross value of Australian nursery production in 2015–16 totalled $724 million (in 2015–16 dollars) (ABS 2017a). Nursery businesses employ 19,000 full time equivalents (HIA 2018). An assessment of the impact of a Xylella outbreak on the nurseries has not been attempted in this study.

## 2.4 There are environmental impacts

Xylella also poses potential risks to many native and introduced species valued for the ecosystem services they provide. These plant species are found in natural vegetation, nature reserves, both old growth and planted (commercial) forests, urban corridors, streetscapes, and home gardens. Some Australian native forest and woodland trees and introduced plant species found in overseas countries are reported to be affected by Xylella (Rathé et al. 2012; EFSA 2016; Almeida & Nunney 2015).

# 3 Impacts are underpinned by Xylella's spread

## 3.1 Which cropping areas will be affected?

Following its entry, the locations where *X. fastidiosa* will establish depend on the conduciveness of the local habitat for both the pathogen and vector. For the range of crops considered, the suitability of habitat in locations where they are grown is highly variable and largely unknown. This is because, depending on the *X. fastidiosa* subspecies and vector, the suitability of the habitat is determined by a wide range of factors, such as: minimum winter temperature; maximum summer temperature; humidity; over-summering, or over-wintering habits of both the pathogen and insect vectors; and the presence and absence of host plants other than susceptible crops. Given these uncertainties, it is assumed that all growing areas of all susceptible crops would be at risk of disease establishment.

## 3.2 How fast would Xylella spread?

Little is known about how quickly *X. fastidiosa* spreads across cropping areas, and therefore the spread rate assumptions made in Hafi et al. (2017) were used in this study as well. That is, the within-farm spread rate measured in terms of percentage of trees lost per year was assumed to grow exponentially over the first 10-year period until it reached a maximum in the 10th year. The growth rate continues at the maximum rate until all trees are infected. Two within-farm spread trajectories were developed: one assuming a 10% maximum rate reached in 10 years (fast spread) and the other assuming a 4% maximum rate reached in 10 years (slow spread). It is also assumed that the disease would spread rapidly between farms within a region and any of the subspecies considered would be immediately present in all regions. Mirroring within-farm spread over time, the economic impacts of *X. fastidiosa*'s spread are assumed to extend over 50 years or until all trees are infected.

## 3.3 Farm level adjustment costs following tree death

It is assumed the only adjustment option post incursion is to replace the affected trees with trees from resistant varieties of the same crop. The farm level cost is therefore defined as the on-farm adjustment costs of replacing affected trees, which include all costs of adjustment and losses of revenue until the adjustment process is completed. This is the same method as that used by Hafi et al. (2017) to estimate farm-level adjustment costs.

It should be noted that there is uncertainty about the magnitude of the (undiscounted) farm level impacts. Given the number of crops involved, this study has assumed producers remain undertaking the activities that existed prior to an Xylella incursion rather than shifting into alternative activities (for example livestock). For detailed project appraisal it would likely be useful to understand the range of potential impacts through more detailed analysis of alternative investment choices or through additional sensitivity analysis.

## 3.4 Farm level costs accumulate as Xylella spreads

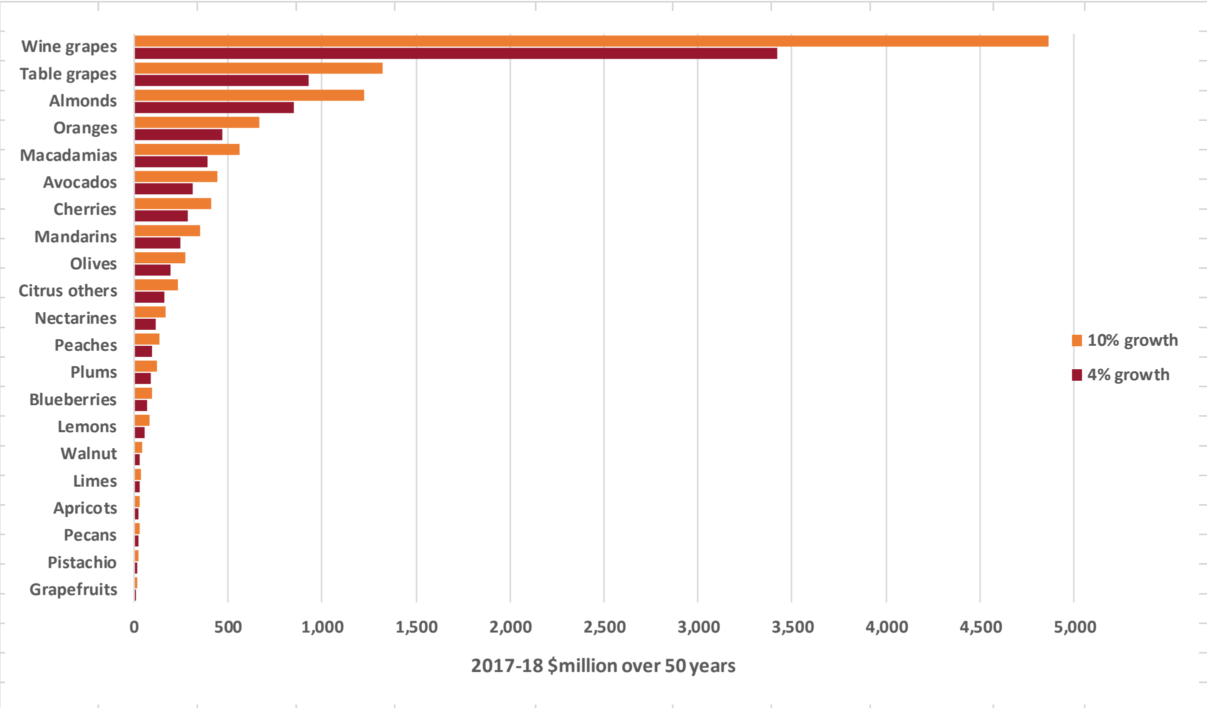
For each jurisdiction, spread trajectory and susceptible crop, direct costs were estimated over a 50-year period. This was done in 3 steps.

1. The state level cost was estimated for each year as the average farm-level total cost per hectare multiplied by the number of hectares affected, as determined by the rate of *X. fastidiosa* spread in that year.
2. The national-level cost was estimated for each year by adding state totals.
3. The sum of present values over 50 years was estimated using a discount rate of 3%.

# 4 A maximum cropping industry cost of $11 billion

The entry and establishment of *X. fastidiosa* subspecies affecting all susceptible crops is estimated to cost between $7.8 billion to $11.1 billion over 50 years (2017–18 dollars estimated at a 3% discount rate). The lower and higher estimates correspond to slower (4%) and faster (10%) spread rates. All susceptible crops could be affected from any of the entry scenarios involving subspecies *fastidiosa, multiplex* and all unspecified subspecies. A breakdown of each of these estimates by crop and state is presented in Figure 1 and Figure 2, respectively.

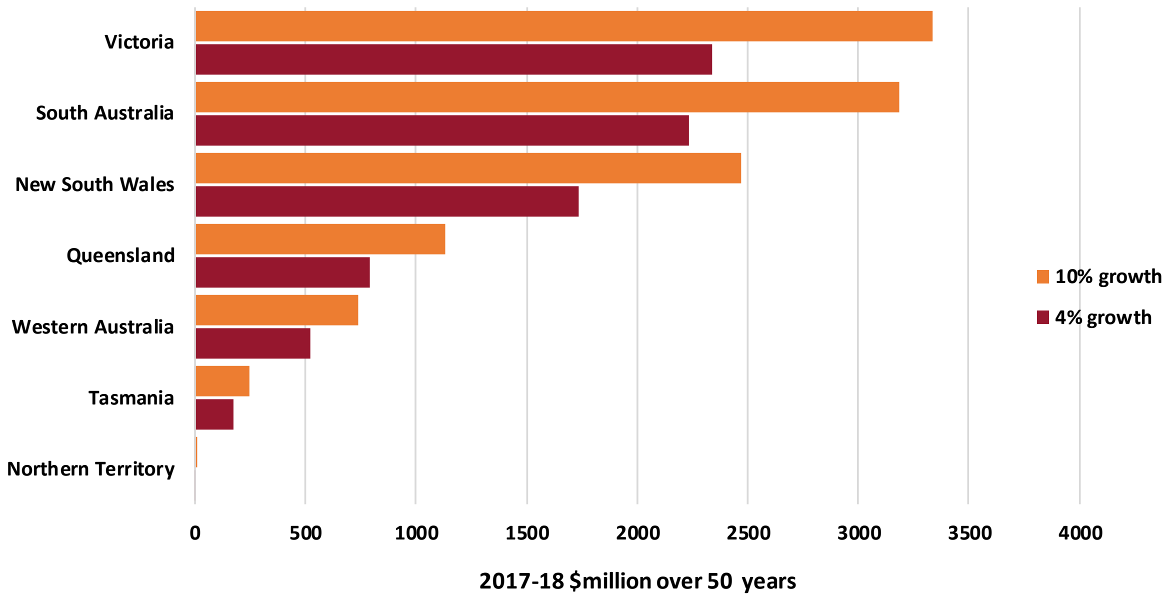
**Figure 1 Cost of *X. fastidiosa*, by crop and spread rate over 50 years if all susceptible crops are affected[a]**




**a** All susceptible crops could be affected from any of the entry scenarios involving subspecies *fastidiosa, multiplex* and all unspecified subspecies.

Note: All dollar values are present values estimated using a 3% discount rate.

## Figure 2 Cost of *X. fas*tidiosa, by jurisdiction and spread rate over 50 years if all susceptible crops are affected[a]




**a** All susceptible crops could be affected from any of the entry scenarios involving subspecies *fastidiosa, multiplex* and all unspecified subspecies.
Note: All dollar values are present values estimated using a 3% discount rate.

### Box 1 Choosing an appropriate discount rate

The standard discount rate for government economic appraisals is 7 per cent, with sensitivity analysis of 3 and 10 per cent (Australian Government 2020). The sensitivity analysis is intended to capture potential differences in risk associated with projects. Projects that are risk free are discounted at 3 per cent.

Where projects involve risk, adjustments are needed to make them less attractive by including the cost of risk (also known as a risk premium). Increasing the discount rate is typically one way of implementing these adjustments, since it reduces the present value of future benefits. This is the rationale for the 7 and 10 per cent discount rates, depending on the level of risk involved.

In the context of this report, a discount rate higher than the risk-free rate should only be used if Xylella entering and establishing in Australia decreases risk. This is because we are modelling costs rather than benefits (Stiglitz and Rosengard 2015). Higher discount rates reduce the present value of future costs, making Xylella appear to be less of a problem.

As it seems unlikely that Xylella entering and establishing in Australia would decrease risk, this analysis uses a 3 per cent discount rate to generate a conservative estimate of the costs of Xylella. ABARES also reports the results with 7 and 10 per cent discount rates in Appendix A ( Table A 3, Table A 4, Table A 5 and Table A 6), to facilitate comparisons with previous studies that have applied higher discount rates. As noted above, use of these higher discount rates is likely to underestimate the costs of Xylella.

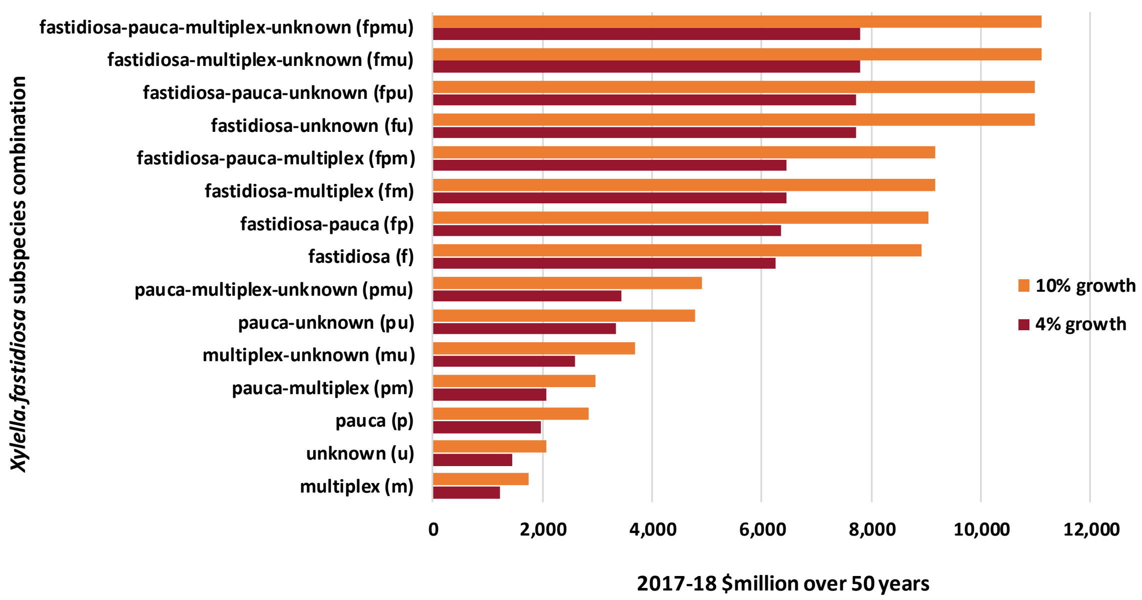
Accounting for risk will be important in any subsequent assessments of projects to mitigate the risk of Xylella. These assessments should consider uncertainties around whether Xylella will enter and the effectiveness of the mitigation projects, which are outside the scope of this report. ABARES is developing methods to capture these risks in a straightforward and rigorous way.

There are 13 industries, each estimated to lose over $100 million over 50 years at a 10% spread rate. The wine grape industry tops the list with an estimated loss of $4.86 billion, followed by the table grape ($1.32b), almond ($1.22b), orange ($0.67b), macadamia ($0.56b), avocado ($0.44b), cherry ($0.41b) and mandarin ($0.35b) industries (Figure 1). Xylella is estimated to cost Victoria and South Australia the most, with an estimated cost of $3.34 billion and $3.18 billion respectively at a 10% spread rate, followed by New South Wales ($2.47 billion) and Queensland ($1.13 billion) (Figure 2). Detailed estimates of direct economic cost by state, susceptible crop and spread rates are provided in Appendix A (Table A1 and Table A2).

### 4.1.1 Costs depend on which subspecies enter

A key determinant of the cost is the number of *X.fastiodasa*-susceptible crops that would be affected after an incursion, which in turn is determined by the particular subspecies or combination of subspecies that enter and establish in Australia. The subspecies *fastidiosa* affects 8 crops, *multiplex* 5 crops, *pauca* 6 crops, and all unspecified subspecies 11 crops. Some crops are affected by multiple subspecies. Crops affected by *pauca* are all also affected by at least one other sub species. Figure 3 presents the range of national level cost estimates across these events, along with estimates for the 2 events that could result in all susceptible crops being affected (the top 2 sets of horizontal bars).

**Figure 3 The range of national level impacts of X. fastidiosa by subspecies combination**



# 5 Impacts on downstream and nursery industries

The costs of *X. fastidiosa* are expected to extend well beyond the affected host-crop industries. The impact of decreased production while new plantings come into bearing will likely flow on to industries that supply goods and services (inputs) to horticultural producers, and depending on substitutes, those engaged in fruit processing and other value-adding activities and businesses providing marketing services. A large-scale replanting of trees in response to an incursion would also result in increased demand for inputs such as *Xylella*-resistant planting materials, labour, machinery and other inputs.

## 5.1 Significant impact on downstream industries

Around quarter of *Xylella*-susceptible crop production (excluding wine grapes) was used by processing industries in 2017–18. The intermediate input uses in the 'fruits and vegetables processing' sector in the Australian Input-Output table for 2017–18 (ABS 2019a) show that fresh farm products are the key input used, accounting for 25% of the sale value of processed fruits and vegetables. Of the other inputs used, labour accounts for 17%, wholesale trade 12%, other food products 11% and transport 5%. As use of imported fresh fruit as a substitute in the domestic processing is unlikely to be economically viable, any reduction in fresh fruit inputs going into processing because of Xylella damage is expected to reduce processing output, and lead to reduced derived demand for the other inputs, including labour. This could lead to reduced incomes for the labour used in fruit processing, and reduced revenue for the wholesale trade, other food products and transport industries. Impacts further along value chains, where processed product is used as an input to further processing, will be mitigated by the extent that imported products can substitute for domestically sourced intermediate inputs.

Wine grapes are the highest value crop that could be affected by Xylella. The flow-on impacts generated from Xylella damage to wine grapes are expected to be the highest of all susceptible crops because all wine grapes are processed into wine and viable options for importing wine grapes for processing in Australia are unlikely. If Xylella were to spread across 10% of all wine grape growing areas a year, the disease would cost the wine-making industry $10.21 billion at a 3% discount rate (converted from the estimate in Hafi et al. (2017) of $5.25 billion in 2017–18 dollars over 50 years at a 7% discount rate). At a 4% spread rate, this impact is estimated to be lower, at $7.20 billion at a 3% discount rate (converted from the estimate in Hafi et al. (2017) of $3.70 billion in 2017–18 dollars over 50 years at a 7% discount rate). Similar flow-on impacts to downstream industries relying on other susceptible crops have not been estimated.

## 5.2 Nursery industry could suffer

Should Xylella become endemic in Australia it could affect the nursery industry as described in section 2.3; costs of complying with movement restrictions and phytosanitary requirements, from damage to product, and from actions to mitigate damage. The resulting impacts can be significant to both production and retail nurseries. These impacts are not estimated in this study because little information is available on the details of movement control measures that would be implemented and their impacts.

# 6 Non-market impacts are likely

Potential non-market impacts from *X. fastidiosa* include environmental, cultural and social impacts. Environmental impacts arise from reduced populations of native plant species (or reduced biodiversity), leading to reduced ecosystem services provided by those species. Xylella could also cause loss of assets with significant cultural and heritage values, such as old or monumental trees, resulting in social impacts in the form of psychological or emotional distress to people.

There are estimates available in the literature of the willingness to pay for different environmental goods that can be affected by biosecurity threats to plant species in general, as well as for specific threats. However, none of these estimates were found to be suitable for approximating the mixture of potential environmental impacts of Xylella in Australia. To provide some context, the discussion below provides information on the non-crop species that could be affected and the nature of potential impacts.

## 6.1 Non-crop plant species under threat in Australia

It has been generally known that a wide range of Australian native species could be vulnerable to *X. fastidiosa*. Rathé et al. (2012) found 3 species – *Hackea petiolaris*, *Leptospermum laevigatum* and *Swainsona galegifolia*, commonly found in Australian home gardens – could be affected. *H. petiolaris* is commercially grown for cut flowers, *L. laevigatum* is widespread as a coastal shrub while *S. galegifolia is* found across a wide range of habitats. Rathé et al. (2012) also observed that these plant populations could provide a reservoir of hosts for *X. fastidiosa* from which the pathogen could spread further afield. There is anecdotal evidence suggesting that some Australian natives—including golden wreath wattles (*Acacia saligna*), hop-bush (*Dodonaea viscosa*) and rosemary (*Westringual fruticos*)—currently being grown in Europe are affected by Xylella (Low 2017). But at the same time, there has been no reported impact of Xylella on Eucalyptus of the *Myrtaceae* family (mostly Australian native) and little impact on silver wattles (*Acacia dealbata*) currently being grown in Europe.

A growing number of plant species introduced to Australia from Europe and North America are now known to be affected by Xylella in locations where it is currently spreading. There is growing evidence of the disease affecting American natives, such as elms, maples, oaks, oleander and sycamores in North America. Many of these plant species are found in gardens, parks and streetscapes in Australia (QDAF 2016).

## 6.2 Potential non-market impacts

Low (2017) notes that there is no evidence that the disease has caused large scale tree deaths in natural vegetation. Anecdotal evidence from southern France suggests that the disease is not infecting natural vegetation found near infected crops, either. Further, despite evidence of Xylella affecting native elms, maples, oaks and sycamores in the United States, there are no reports of tree deaths.

There is no evidence that Xylella has already caused or is causing species extinction. A more plausible scenario for the impact of Xylella in a native Australian species could be some tree kills. This could result in a reduction in tree numbers and a weakening of the remaining disease-affected trees. These two effects could jointly contribute to a reduction in some ecosystem services. However, there is little information available on the value people would place on such an impact.

In a contingency plan prepared for Xylella, QDAF (2016) rated the risk of environmental impacts to be lower than the risk of impact on agricultural and amenity plants. While this conclusion appears reasonable given the international experience there is significant uncertainty.

# Appendix A: Results in detail

### Table A1 Estimated direct economic cost by Xylella-susceptible crop and jurisdiction at a 4% spread rate and 3% discount rate)

| Crop | NSW | NT | Qld | SA | Tasmania | Victoria | WA | Australia |
|---|---|---|---|---|---|---|---|---|
| | | | | | 2017–18 $million[a] | | | |
| Wine grapes | 918.5 | 0.0 | 6.4 | 1,684.7 | 44.1 | 522.3 | 247.6 | 3,423.7 |
| Table grapes | 146.1 | 4.6 | 93.8 | 9.1 | 0.0 | 639.5 | 36.1 | 929.2 |
| Almonds | 75.3 | 0.0 | 0.0 | 159.3 | 0.0 | 608.0 | 9.0 | 851.6 |
| Oranges | 170.0 | 0.0 | 4.6 | 189.1 | 0.0 | 80.3 | 23.8 | 467.8 |
| Macadamias | 155.4 | 0.0 | 235.0 | 0.0 | 0.0 | 0.0 | 0.0 | 390.4 |
| Avocados | 44.6 | 0.1 | 157.6 | 7.2 | 0.2 | 5.5 | 94.9 | 310.1 |
| Cherries | 35.9 | 0.0 | 0.1 | 20.7 | 107.7 | 121.3 | 1.7 | 287.4 |
| Mandarins | 13.2 | 0.0 | 117.1 | 81.8 | 0.0 | 23.8 | 8.8 | 244.7 |
| Olives | 28.9 | 0.0 | 8.7 | 20.2 | 0.6 | 86.0 | 47.4 | 191.8 |
| Citrus, other | 13.0 | 0.4 | 93.2 | 32.2 | 0.0 | 18.5 | 3.7 | 161.1 |
| Nectarines | 7.8 | 0.0 | 2.5 | 9.0 | 0.0 | 80.4 | 15.8 | 115.6 |
| Peaches | 7.7 | 0.0 | 2.7 | 5.5 | 0.0 | 68.1 | 9.8 | 93.8 |
| Plums | 17.0 | 0.0 | 5.3 | 1.8 | 0.0 | 46.9 | 14.7 | 85.8 |
| Blueberries | 48.9 | 0.0 | 8.6 | 0.1 | 5.5 | 3.2 | 1.0 | 67.4 |
| Lemons | 8.9 | 0.0 | 27.7 | 7.6 | 0.0 | 11.2 | 1.5 | 56.8 |
| Walnuts | 15.8 | 0.0 | 0.0 | 0.6 | 9.8 | 3.1 | 0.1 | 29.4 |
| Limes | 0.9 | 0.2 | 22.5 | 0.9 | 0.0 | 1.1 | 1.2 | 26.8 |
| Apricots | 0.6 | 0.0 | 0.4 | 4.6 | 4.2 | 10.6 | 0.3 | 20.7 |
| Pecans | 16.4 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 | 0.2 | 20.2 |
| Pistachios | 7.4 | 0.0 | 0.0 | 1.1 | 0.0 | 6.3 | 0.4 | 15.1 |
| Grapefruit | 4.8 | 0.0 | 1.5 | 1.5 | 0.0 | 1.7 | 0.7 | 10.2 |
| Total | 1,737.1 | 5.3 | 791.4 | 2,237.1 | 172.1 | 2,338.1 | 518.6 | 7,799.6 |

**a** In present value terms estimated over 50 years at a 3% discount rate.

## Table A2 Estimated direct economic cost by Xylella susceptible crop and jurisdiction at a 10% spread rate and 3% discount rate)

| Crop | NSW | NT | Qld | SA | Tasmania | Victoria | WA | Australia |
|---|---|---|---|---|---|---|---|---|
| | | | | 2017–18 $million[a] | | | | |
| Wine grapes | 1,304.7 | 0.0 | 9.1 | 2,393.5 | 62.7 | 741.9 | 351.8 | 4,863.8 |
| Table grapes | 208.1 | 6.5 | 133.4 | 13.0 | 0.0 | 910.5 | 51.4 | 1,322.8 |
| Almonds | 108.1 | 0.0 | 0.0 | 229.0 | 0.0 | 873.9 | 12.8 | 1,223.8 |
| Oranges | 242.2 | 0.0 | 6.6 | 269.8 | 0.0 | 114.5 | 33.9 | 667.0 |
| Macadamias | 222.0 | 0.0 | 336.0 | 0.0 | 0.0 | 0.0 | 0.0 | 557.9 |
| Avocados | 63.7 | 0.1 | 225.0 | 10.3 | 0.3 | 7.9 | 135.5 | 442.7 |
| Cherries | 51.4 | 0.0 | 0.2 | 29.6 | 154.8 | 174.3 | 2.5 | 412.6 |
| Mandarins | 18.8 | 0.0 | 167.2 | 116.7 | 0.0 | 34.0 | 12.5 | 349.3 |
| Olives | 41.2 | 0.0 | 12.3 | 28.8 | 0.8 | 122.7 | 67.4 | 273.3 |
| Citrus, other | 18.5 | 0.6 | 133.1 | 46.1 | 0.0 | 26.4 | 5.3 | 230.0 |
| Nectarines | 11.2 | 0.0 | 3.6 | 12.8 | 0.0 | 114.7 | 22.5 | 164.8 |
| Peaches | 11.0 | 0.0 | 3.8 | 7.8 | 0.0 | 97.1 | 14.0 | 133.6 |
| Plums | 24.3 | 0.0 | 7.6 | 2.5 | 0.1 | 66.9 | 20.9 | 122.3 |
| Blueberries | 69.6 | 0.0 | 12.3 | 0.1 | 7.9 | 4.6 | 1.4 | 95.8 |
| Lemons | 12.7 | 0.0 | 39.5 | 10.8 | 0.0 | 16.0 | 2.1 | 81.0 |
| Walnuts | 22.6 | 0.0 | 0.0 | 0.9 | 13.9 | 4.4 | 0.1 | 41.9 |
| Limes | 1.3 | 0.3 | 32.1 | 1.2 | 0.0 | 1.6 | 1.7 | 38.3 |
| Apricots | 0.8 | 0.0 | 0.5 | 6.6 | 5.9 | 15.1 | 0.5 | 29.5 |
| Pecans | 23.4 | 0.0 | 5.2 | 0.0 | 0.0 | 0.0 | 0.3 | 28.9 |
| Pistachios | 10.6 | 0.0 | 0.0 | 1.5 | 0.0 | 9.0 | 0.5 | 21.6 |
| Grapefruit | 6.8 | 0.0 | 2.1 | 2.2 | 0.0 | 2.4 | 0.9 | 14.5 |
| Total | 2,472.9 | 7.5 | 1,129.5 | 3,183.4 | 246.3 | 3,337.8 | 738.1 | 11,115.5 |

**a** In present value terms estimated over 50 years at a 3% discount rate.

## Table A 3 Estimated direct economic cost by Xylella-susceptible crop and jurisdiction (at a 4% spread rate and 7% discount rate)

| Crop | NSW | NT | Qld | SA | Tasmania | Victoria | WA | Australia |
|---|---|---|---|---|---|---|---|---|
| | | | | 2017–18 $ million[a] | | | | |
| Wine grapes | 437.9 | 0.0 | 3.1 | 801.8 | 20.7 | 249.2 | 117.9 | 1630.7 |
| Table grapes | 68.2 | 2.2 | 44.0 | 4.2 | 0.0 | 298.9 | 16.8 | 434.3 |
| Almonds | 33.0 | 0.0 | 0.0 | 69.3 | 0.0 | 264.6 | 4.2 | 371.2 |
| Oranges | 78.9 | 0.0 | 2.1 | 86.7 | 0.0 | 36.9 | 11.0 | 215.6 |
| Macadamias | 70.5 | 0.0 | 106.1 | 0.0 | 0.0 | 0.0 | 0.0 | 176.6 |
| Avocados | 20.4 | 0.0 | 71.6 | 3.3 | 0.1 | 2.5 | 43.2 | 141.2 |
| Cherries | 15.9 | 0.0 | 0.0 | 9.3 | 46.7 | 52.8 | 0.8 | 125.5 |
| Mandarins | 6.1 | 0.0 | 53.5 | 37.2 | 0.0 | 10.9 | 4.1 | 111.9 |
| Olives | 13.3 | 0.0 | 4.2 | 9.4 | 0.3 | 39.7 | 22.3 | 89.1 |
| Citrus, other | 5.6 | 0.1 | 32.3 | 14.3 | 0.0 | 8.0 | 1.1 | 61.3 |
| Nectarines | 3.7 | 0.0 | 1.2 | 4.1 | 0.0 | 37.1 | 7.3 | 53.3 |
| Peaches | 3.6 | 0.0 | 1.2 | 2.5 | 0.0 | 31.7 | 4.5 | 43.6 |
| Plums | 7.8 | 0.0 | 2.5 | 0.8 | 0.0 | 21.5 | 6.7 | 39.4 |
| Blueberries | 23.1 | 0.0 | 4.1 | 0.0 | 2.6 | 1.5 | 0.5 | 31.7 |
| Lemons | 4.0 | 0.0 | 12.6 | 3.4 | 0.0 | 5.1 | 0.7 | 25.9 |
| Walnuts | 7.0 | 0.0 | 0.0 | 0.3 | 4.6 | 1.4 | 0.0 | 13.3 |
| Limes | 0.4 | 0.1 | 10.3 | 0.4 | 0.0 | 0.5 | 0.6 | 12.3 |
| Apricots | 0.3 | 0.0 | 0.2 | 2.2 | 2.0 | 5.1 | 0.2 | 9.9 |
| Pecans | 7.5 | 0.0 | 1.6 | 0.0 | 0.0 | 0.0 | 0.1 | 9.2 |
| Pistachios | 3.3 | 0.0 | 0.0 | 0.5 | 0.0 | 2.8 | 0.2 | 6.7 |
| Grapefruit | 2.2 | 0.0 | 0.7 | 0.7 | 0.0 | 0.8 | 0.3 | 4.7 |
| Total | 812.6 | 2.4 | 351.3 | 1050.6 | 77.0 | 1071.0 | 242.5 | 3607.3 |

**a** In present value terms estimated over 50 years at a 7% discount rate.

## Table A 4 Estimated direct economic cost by Xylella susceptible crop and jurisdiction (at a 10% spread rate and 7% discount rate)

| Crop | NSW | NT | Qld | SA | Tasmania | Victoria | WA | Australia |
|---|---|---|---|---|---|---|---|---|
| | | | | | 2017–18 $ million[a] | | | |
| Wine grapes | 717.1 | 0.0 | 5.0 | 1313.3 | 34.0 | 408.2 | 193.2 | 2670.9 |
| Table grapes | 111.7 | 3.6 | 72.2 | 6.9 | 0.0 | 489.9 | 27.6 | 711.8 |
| Almonds | 54.3 | 0.0 | 0.0 | 114.0 | 0.0 | 435.0 | 6.9 | 610.2 |
| Oranges | 129.4 | 0.0 | 3.5 | 142.1 | 0.0 | 60.5 | 18.0 | 353.5 |
| Macadamias | 115.6 | 0.0 | 174.1 | 0.0 | 0.0 | 0.0 | 0.0 | 289.8 |
| Avocados | 33.4 | 0.1 | 117.5 | 5.4 | 0.1 | 4.1 | 70.9 | 231.6 |
| Cherries | 26.1 | 0.0 | 0.1 | 15.3 | 76.8 | 86.7 | 1.3 | 206.2 |
| Mandarins | 10.1 | 0.0 | 87.8 | 61.1 | 0.0 | 17.9 | 6.7 | 183.5 |
| Olives | 21.8 | 0.0 | 6.8 | 15.4 | 0.4 | 65.0 | 36.6 | 146.2 |
| Citrus, other | 9.1 | 0.1 | 52.9 | 23.4 | 0.0 | 13.0 | 1.9 | 100.5 |
| Nectarines | 6.0 | 0.0 | 2.0 | 6.7 | 0.0 | 60.8 | 11.9 | 87.4 |
| Peaches | 5.9 | 0.0 | 2.0 | 4.1 | 0.0 | 51.9 | 7.4 | 71.5 |
| Plums | 12.8 | 0.0 | 4.0 | 1.3 | 0.0 | 35.3 | 11.0 | 64.6 |
| Blueberries | 37.8 | 0.0 | 6.6 | 0.1 | 4.3 | 2.5 | 0.7 | 52.0 |
| Lemons | 6.6 | 0.0 | 20.7 | 5.7 | 0.0 | 8.4 | 1.1 | 42.5 |
| Walnuts | 11.5 | 0.0 | 0.0 | 0.5 | 7.5 | 2.4 | 0.0 | 21.9 |
| Limes | 0.7 | 0.2 | 16.8 | 0.6 | 0.0 | 0.8 | 0.9 | 20.1 |
| Apricots | 0.5 | 0.0 | 0.3 | 3.6 | 3.3 | 8.3 | 0.3 | 16.2 |
| Pecans | 12.2 | 0.0 | 2.7 | 0.0 | 0.0 | 0.0 | 0.2 | 15.1 |
| Pistachios | 5.4 | 0.0 | 0.0 | 0.8 | 0.0 | 4.7 | 0.3 | 11.1 |
| Grapefruit | 3.6 | 0.0 | 1.1 | 1.2 | 0.0 | 1.3 | 0.5 | 7.7 |
| Total | 1331.7 | 3.9 | 576.3 | 1721.6 | 126.4 | 1756.8 | 397.5 | 5914.1 |

**a** In present value terms estimated over 50 years at a 7% discount rate.

## Table A 5 Estimated direct economic cost by Xylella-susceptible crop and jurisdiction (at a 4% spread rate and 10% discount rate)

| Crop | NSW | NT | Qld | SA | Tasmania | Victoria | WA | Australia |
|---|---|---|---|---|---|---|---|---|
| | | | | | 2017–18 $ million[a] | | | |
| Wine grapes | 263.2 | 0.0 | 1.9 | 481.4 | 12.3 | 149.9 | 70.8 | 979.5 |
| Table grapes | 41.8 | 1.3 | 27.1 | 2.6 | 0.0 | 183.4 | 10.3 | 266.6 |
| Almonds | 19.4 | 0.0 | 0.0 | 40.4 | 0.0 | 154.4 | 2.6 | 216.9 |
| Oranges | 48.2 | 0.0 | 1.3 | 52.4 | 0.0 | 22.3 | 6.7 | 130.9 |
| Macadamias | 42.3 | 0.0 | 63.4 | 0.0 | 0.0 | 0.0 | 0.0 | 105.7 |
| Avocados | 12.3 | 0.0 | 43.0 | 2.0 | 0.1 | 1.5 | 26.0 | 84.9 |
| Cherries | 9.4 | 0.0 | 0.0 | 5.5 | 27.1 | 30.7 | 0.5 | 73.2 |
| Mandarins | 3.7 | 0.0 | 32.3 | 22.4 | 0.0 | 6.6 | 2.5 | 67.5 |
| Olives | 8.1 | 0.0 | 2.6 | 5.8 | 0.2 | 24.1 | 13.8 | 54.5 |
| Citrus, other | 3.6 | 0.1 | 25.6 | 8.8 | 0.0 | 5.1 | 1.0 | 44.3 |
| Nectarines | 2.2 | 0.0 | 0.7 | 2.5 | 0.0 | 22.5 | 4.4 | 32.4 |
| Peaches | 2.2 | 0.0 | 0.8 | 1.5 | 0.0 | 19.4 | 2.8 | 26.6 |
| Plums | 4.7 | 0.0 | 1.5 | 0.5 | 0.0 | 13.1 | 4.1 | 23.8 |
| Blueberries | 14.2 | 0.0 | 2.5 | 0.0 | 1.6 | 0.9 | 0.3 | 19.6 |
| Lemons | 2.4 | 0.0 | 7.6 | 2.1 | 0.0 | 3.1 | 0.4 | 15.6 |
| Walnuts | 4.2 | 0.0 | 0.0 | 0.2 | 2.8 | 0.9 | 0.0 | 8.0 |
| Limes | 0.3 | 0.1 | 6.2 | 0.2 | 0.0 | 0.3 | 0.3 | 7.4 |
| Apricots | 0.2 | 0.0 | 0.1 | 1.4 | 1.2 | 3.2 | 0.1 | 6.1 |
| Pecans | 4.5 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.1 | 5.5 |
| Pistachios | 1.9 | 0.0 | 0.0 | 0.3 | 0.0 | 1.7 | 0.1 | 4.0 |
| Grapefruit | 1.3 | 0.0 | 0.4 | 0.4 | 0.0 | 0.5 | 0.2 | 2.8 |
| Total | 490.1 | 1.5 | 218.1 | 630.3 | 45.3 | 643.5 | 146.9 | 2175.9 |

**a** In present value terms estimated over 50 years at a 10% discount rate.

## Table A 6 Estimated direct economic cost by Xylella susceptible crop and jurisdiction (at a 10% spread rate and a 10% discount rate)

| Crop | NSW | NT | Qld | SA | Tasmania | Victoria | WA | Australia |
|---|---|---|---|---|---|---|---|---|
| | | | | | 2017–18 $ million[a] | | | |
| Wine grapes | 463.2 | 0.0 | 3.3 | 847.3 | 21.7 | 263.8 | 124.7 | 1723.9 |
| Table grapes | 73.6 | 2.4 | 47.8 | 4.5 | 0.0 | 322.9 | 18.1 | 469.3 |
| Almonds | 34.2 | 0.0 | 0.0 | 71.3 | 0.0 | 272.2 | 4.6 | 382.3 |
| Oranges | 84.8 | 0.0 | 2.3 | 92.3 | 0.0 | 39.3 | 11.8 | 230.5 |
| Macadamias | 74.5 | 0.0 | 111.7 | 0.0 | 0.0 | 0.0 | 0.0 | 186.2 |
| Avocados | 21.6 | 0.0 | 75.8 | 3.5 | 0.1 | 2.7 | 45.8 | 149.5 |
| Cherries | 16.5 | 0.0 | 0.1 | 9.8 | 47.8 | 54.1 | 0.8 | 129.1 |
| Mandarins | 6.6 | 0.0 | 56.8 | 39.4 | 0.0 | 11.6 | 4.4 | 118.9 |
| Olives | 14.2 | 0.0 | 4.6 | 10.2 | 0.3 | 42.5 | 24.3 | 96.0 |
| Citrus, other | 6.4 | 0.2 | 45.1 | 15.5 | 0.0 | 9.0 | 1.8 | 78.1 |
| Nectarines | 3.9 | 0.0 | 1.3 | 4.4 | 0.0 | 39.7 | 7.8 | 57.0 |
| Peaches | 3.9 | 0.0 | 1.3 | 2.7 | 0.0 | 34.1 | 4.9 | 46.9 |
| Plums | 8.3 | 0.0 | 2.6 | 0.9 | 0.0 | 23.0 | 7.2 | 42.0 |
| Blueberries | 25.0 | 0.0 | 4.4 | 0.1 | 2.8 | 1.7 | 0.5 | 34.5 |
| Lemons | 4.3 | 0.0 | 13.4 | 3.6 | 0.0 | 5.4 | 0.7 | 27.4 |
| Walnuts | 7.3 | 0.0 | 0.0 | 0.3 | 5.0 | 1.6 | 0.0 | 14.2 |
| Limes | 0.4 | 0.1 | 10.9 | 0.4 | 0.0 | 0.5 | 0.6 | 13.0 |
| Apricots | 0.3 | 0.0 | 0.2 | 2.4 | 2.2 | 5.6 | 0.2 | 10.8 |
| Pecans | 7.9 | 0.0 | 1.7 | 0.0 | 0.0 | 0.0 | 0.1 | 9.8 |
| Pistachios | 3.4 | 0.0 | 0.0 | 0.5 | 0.0 | 3.0 | 0.2 | 7.1 |
| Grapefruit | 2.4 | 0.0 | 0.7 | 0.8 | 0.0 | 0.8 | 0.3 | 5.0 |
| Total | 862.9 | 2.7 | 384.1 | 1109.7 | 79.9 | 1133.5 | 258.7 | 3831.5 |

**a** In present value terms estimated over 50 years at a 10% discount rate.

# Glossary

| Term | Definition |
|---|---|
| ABARES | Australian Bureau of Agricultural and Resource Economics and Sciences. |
| ABS | Australian Bureau of Statistics. |
| Discount rate | Interest rate used to discount the value of future costs and benefits to values in the present. |

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