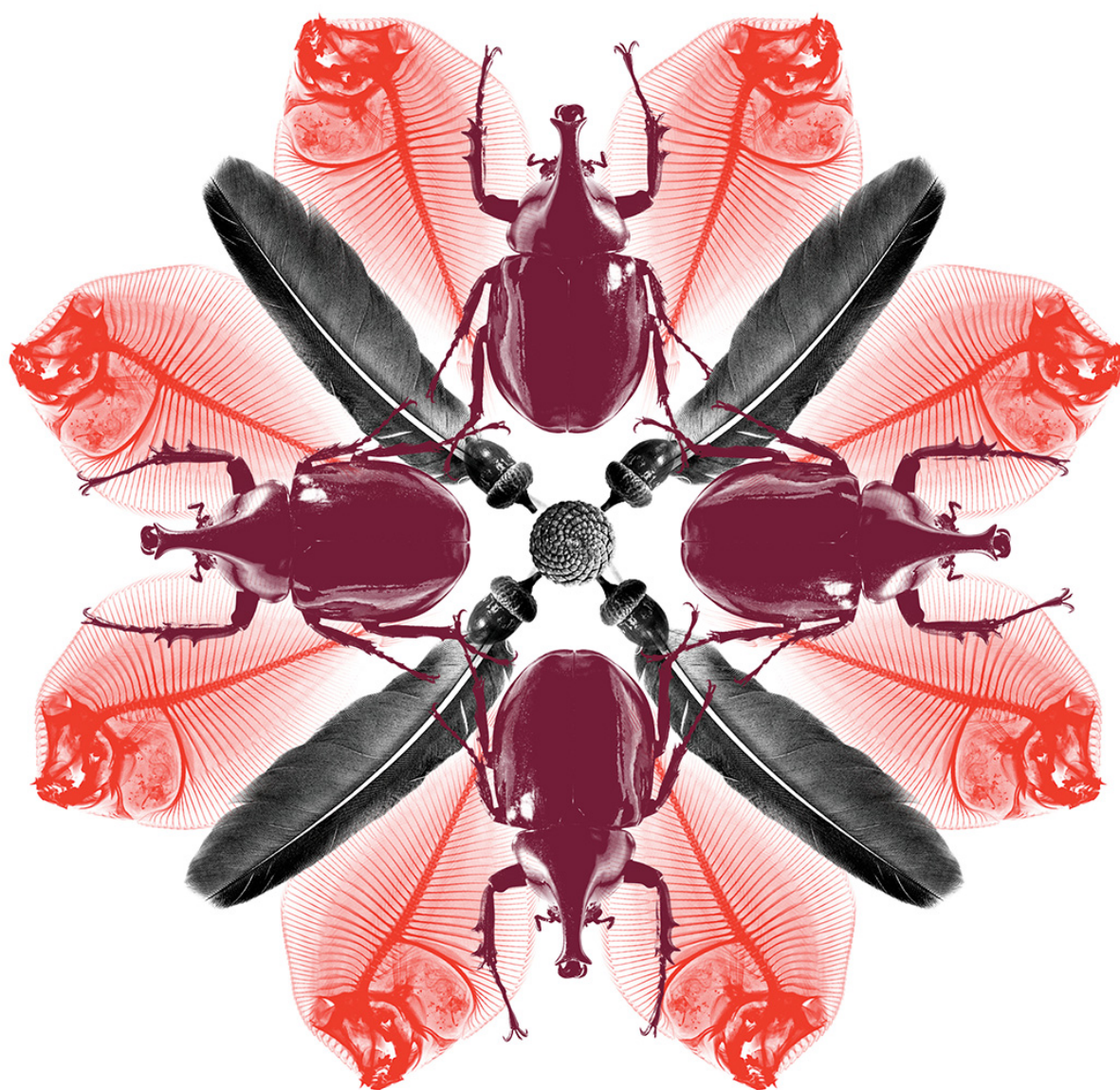




Australian Government
Department of Agriculture
and Water Resources

Draft report for the non-regulated analysis of existing policy for fresh strawberry fruit from the Republic of Korea

August 2016



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Australian Government Department of Agriculture and Water Resources
GPO Box 858 Canberra ACT 2601

Switchboard: +61 2 6272 3933 or 1800 900 090

Facsimile: +61 2 6272 3307

Email: plant@agriculture.gov.au

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Stakeholder submissions on draft reports

This draft report has been issued to give all interested parties an opportunity to comment on relevant technical biosecurity issues, with supporting rationale. A final report will then be produced taking into consideration any comments received.

Submissions should be sent to the Australian Government Department of Agriculture and Water Resources following the conditions specified within the related Biosecurity Advice, which is available at: <http://www.agriculture.gov.au/biosecurity/risk-analysis/memos>

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Map 1 Map of Australia



Map 2 A guide to Australia's bio-climatic zones

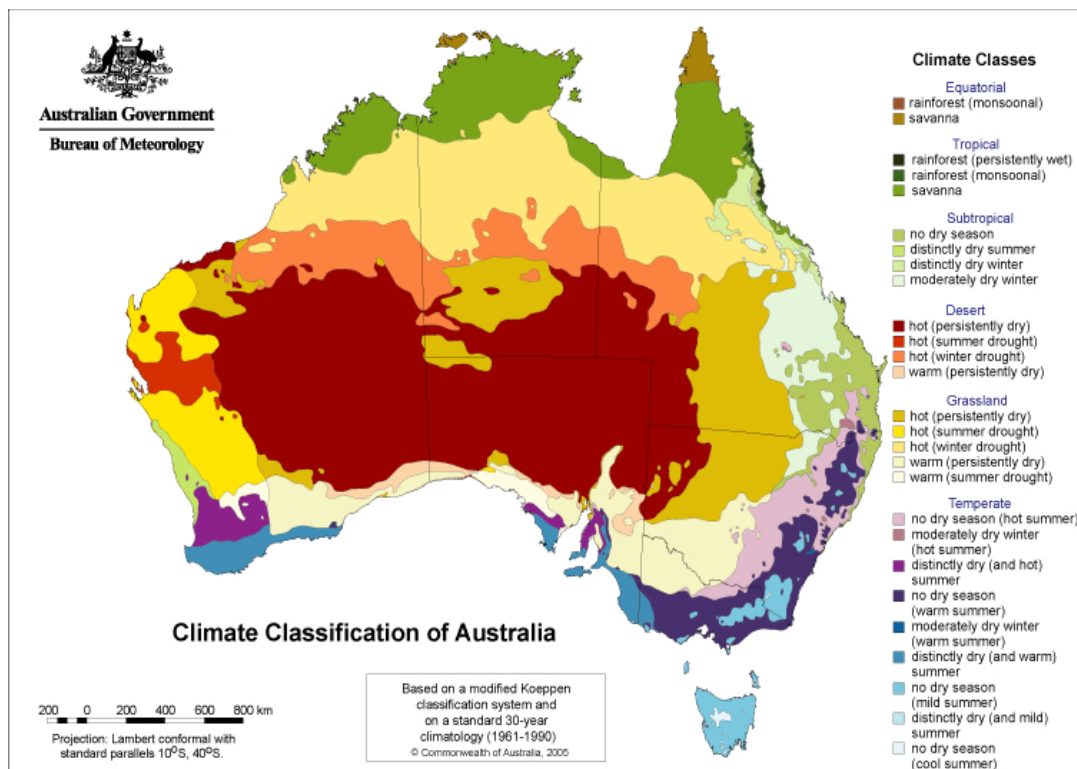
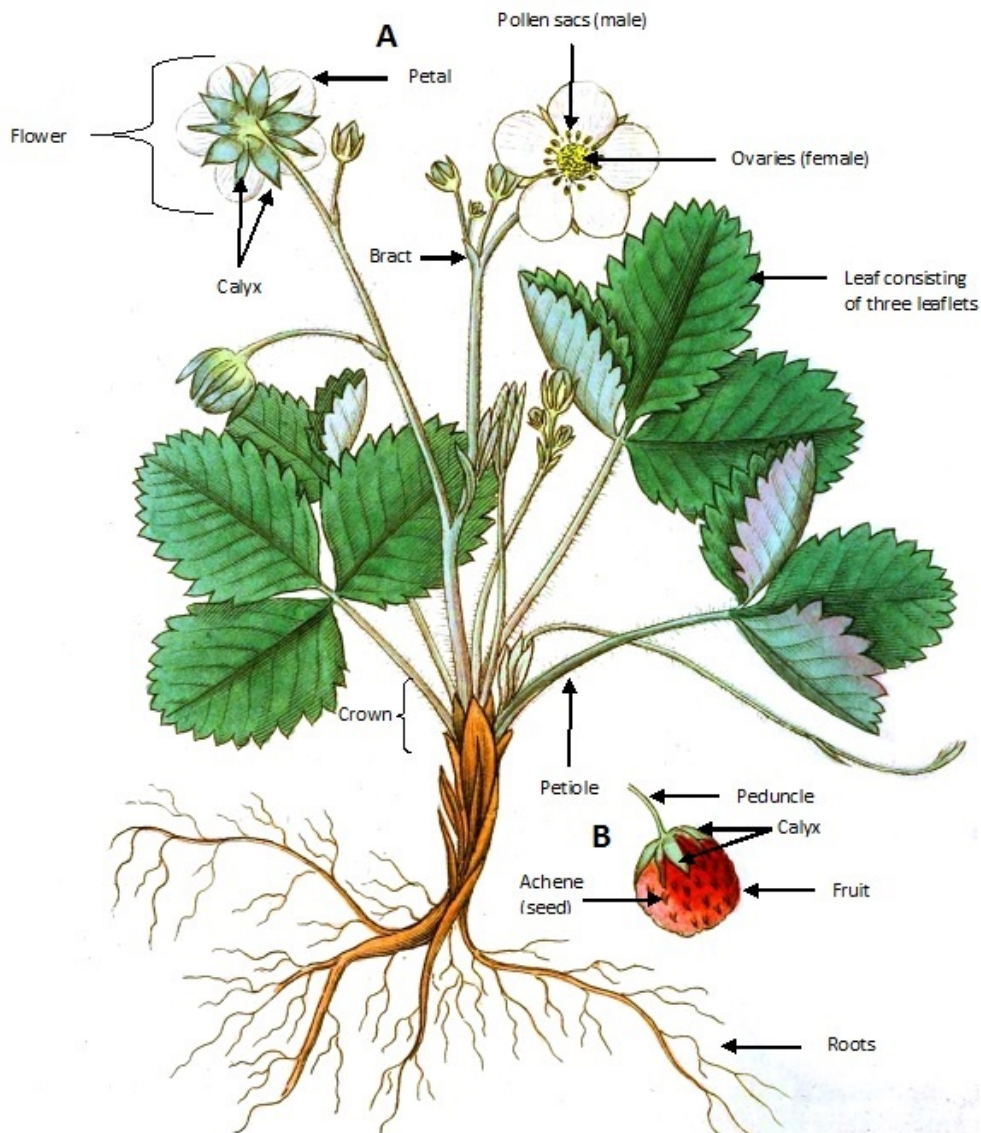


Figure 1 Diagram of strawberries

A shows the main parts of a strawberry runner **B** shows detail of the strawberry fruit
Modified from Svensk Botanik (Palmstruch et al. 1807)

Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
BA	Biosecurity Advice
BICON	Australia's Biosecurity Import Condition System
BIRA	Biosecurity Import Risk Analysis
BLO	Biosecurity Liaison Officer
CABI	CAB International, Wallingford, UK
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Acronym of the former Australian Government Department of Agriculture, Fisheries and Forestry, which is now the Australian Government Department of Agriculture and Water Resources
The department	The Department of Agriculture and Water Resources
EP	Existing policy
FAO	Food and Agriculture Organization of the United Nations
IPC	International Phytosanitary Certificate
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
NSW	New South Wales
NPPO	National Plant Protection Organisation
NPQS	National Plant Quarantine Service (superseded by QIA)
NT	Northern Territory
PRA	Pest risk analysis
Qld	Queensland
QIA	Korea's Animal and Plant Quarantine Agency (since June 2011)
SA	South Australia
SPS Agreement	WTO agreement on the Application of Sanitary and Phytosanitary Measures
Tas.	Tasmania
USA	The United States of America
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization

Summary

The Australian Government Department of Agriculture and Water Resources has prepared this draft report to assess the proposal by the Republic of Korea for market access to Australia for fresh strawberry fruit (strawberries).

Australia has existing import conditions for the import of strawberries for human consumption from New Zealand and California, USA.

This draft report proposes that the importation of commercially greenhouse grown strawberries from the Republic of Korea be permitted, subject to a range of biosecurity conditions.

This draft report identifies five pests that require risk management measures to manage risks to a very low level in order to achieve the appropriate level of protection (ALOP) for Australia. Out of these five pests, four are arthropods and one is a pathogen.

The four arthropod pests requiring measures are *Frankliniella intonsa* (Eurasian flower thrips), *Frankliniella occidentalis* (western flower thrips), *Tetranychus kanzawai* (Kanzawa spider mite) and *Drosophila suzukii* (spotted wing drosophila).

The pathogen pest requiring measures is *Xanthomonas fragariae* (angular leaf spot).

The proposed risk management measures take account of regional differences within Australia. One arthropod pest requiring measures, western flower thrips, has been identified as a quarantine pest for Northern Territory, and another arthropod pest, Kanzawa spider mite, has been identified as a quarantine pest for Western Australia.

This draft report proposes a range of risk management measures, combined with a system of operational procedures to ensure biosecurity standards are met. These measures will reduce the risks posed by the five quarantine pests, and achieve the ALOP for Australia. These measures include:

- visual inspection and, if detected, remedial action for the spider mite and two thrips
- area freedom or fruit treatment (such as methyl bromide fumigation or irradiation) for spotted wing drosophila
- area freedom or a systems approach approved by the Australian Government Department of Agriculture and Water Resources for angular leaf spot
- a supporting operational system to maintain and verify the phytosanitary status of export consignments.

This draft report contains details of the risk assessments for the quarantine pests and the proposed risk management measures in order to allow interested parties to provide comments and submissions to the department within the stakeholder consultation period.

1 Introduction

1.1 Australia's biosecurity policy framework

Australia's biosecurity policies aim to protect Australia against the risks that may arise from exotic pests entering, establishing and spreading in Australia, thereby threatening Australia's unique flora and fauna, as well as those agricultural industries that are relatively free from serious pests.

The risk analysis process is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the level of biosecurity risk that may be associated with proposals to import goods into Australia. If the biosecurity risks do not achieve the appropriate level of protection (ALOP) for Australia, risk management measures are proposed to reduce the risks to an acceptable level. If the risks cannot be reduced to an acceptable level, the goods will not be imported into Australia, until suitable measures are identified.

Successive Australian Governments have maintained a stringent, but not a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of the ALOP for Australia, which reflects community expectations through government policy and is currently described as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's risk analyses are undertaken by the department using technical and scientific experts in relevant fields, and involve consultation with stakeholders at various stages during the process.

Risk analyses may take the form of a biosecurity import risk analysis (BIRA) or a non-regulated risk analysis (such as scientific review of existing policy and import conditions, pest-specific assessments, weed risk assessments, biological control agent assessments or scientific advice).

Further information about Australia's biosecurity framework is provided in the *Biosecurity Import Risk Analysis Guidelines 2016* located on the [Australian Government Department of Agriculture and Water Resources' Biosecurity Import Risk Analysis guidelines website](#).

1.2 This risk analysis

1.2.1 Background

The Republic of Korea (henceforth Korea) formally requested market access for a number of horticultural commodities including strawberries to Australia in a submission received in November 2008 (NPQS 2008). This submission included information on the pests associated with strawberry crops in Korea, including the plant parts affected, and the standard commercial production practices for strawberries in Korea.

In September 2014, Korea advised that market access for strawberries was its top priority. Additional information on production practices and pests was received from Korea in 2015 (QIA 2015b) and 2016 (QIA 2016).

Australia already has established conditions for the importation of strawberries from New Zealand and California (USA). A preliminary pest categorisation for strawberry from Korea indicated the pests and diseases of quarantine concern are the same as or similar to those for

New Zealand and California. For these reasons the department uses a non-regulated risk analysis process to consider this market access request.

On 1 April 2016, the department announced the formal commencement of this risk analysis, advising that it would be progressed as a non-regulated analysis of existing policy.

Officers from the department visited major strawberry production areas in Korea in March 2016, to observe production systems and packing house operations.

1.2.2 Scope

The scope of this risk analysis is to consider the biosecurity risk that may be associated with the importation of fresh strawberry fruit (henceforth strawberries) (*Fragaria × ananassa*), from Korea, for human consumption in Australia.

In this risk analysis, strawberries are defined as strawberry fruit which include calyx, fruit and achenes (seeds) (Figure 1). This risk analysis covers all commercially greenhouse grown strawberries of all cultivars from all strawberry producing regions of Korea.

1.2.3 Existing policy

International policy

Import policy exists for strawberries from New Zealand and California, USA (Department of Agriculture and Water Resources 2016a). Trade of strawberries from these two countries has occurred for over 20 years. Import policies of other commodities which assess known pests of Korean strawberries also exist, for instance, the import policy for table grapes from Korea (Biosecurity Australia 2011b) and the People's Republic of China (Biosecurity Australia 2011a) as well as the import policy for nectarines from China (Australian Government Department of Agriculture and Water Resources 2016).

The import requirements for these commodity pathways can be found at the [department's Biosecurity Import Conditions \(BICON\) website](#). The department has considered all the pests previously assessed in the existing policies and where relevant, the information in previous analyses have been taken into account in this risk analysis.

Domestic arrangements

The Australian Government is responsible for regulating the movement of goods such as plants and plant products into and out of Australia. However, the state and territory governments are responsible for plant health controls within their individual jurisdiction. Legislation relating to resource management or plant health may be used by state and territory government agencies to control interstate movement of plants and their products. Once plant and plant products have been cleared by Australian biosecurity officers, they may be subject to interstate movement conditions. It is the importer's responsibility to identify, and ensure compliance with, all requirements.

1.2.4 Contaminating pests

In addition to the pests associated with strawberries from Korea that are assessed in this risk analysis, there are other organisms that may arrive with the imported commodity. These organisms could include pests of other crops or predators and parasitoids of other arthropods. The department considers these organisms to be contaminating pests that could pose sanitary and phytosanitary risks. These risks are addressed by existing operational procedures that

require a 600 unit inspection of all consignments, or equivalent, and investigation of any pest that may be of quarantine concern to Australia.

1.2.5 Consultation

On 1 April 2016, the department notified stakeholders, in Biosecurity Advice in 2016/09, of the formal commencement of a non-regulated analysis of existing policy to consider a proposal from Korea for market access to Australia for strawberries.

The department has consulted with Korea and Australian state and territory governments during the preparation of this draft report. The department provided a draft pest categorisation to Australian state and territory agricultural departments, for their advance consideration of regional pests.

For the first time, the department is using a Biosecurity Liaison Officer in this risk analysis to enhance two-way communication. The Biosecurity Liaison Officer has conducted face-to-face meetings across Australia with representatives from the strawberry industry and regional representative bodies to discuss the risk analysis process. The Biosecurity Liaison Officer will continue to engage with stakeholders throughout this risk analysis.

1.2.6 Next Steps

This draft report gives stakeholders the opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors.

The department will consider submissions received on the draft report and may consult informally with stakeholders. The department will revise the draft report as appropriate. The department will then prepare a final report, taking into account stakeholder comments.

The final report will be published on the department's website along with a notice advising stakeholders of the release. The department will also notify the proposer, the registered stakeholders and the WTO Secretariat about the release of the final report. Publication of the final report represents the end of the risk analysis process. The conditions recommended in the final report will be the basis of any import permits issued.

2 Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The department has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2007) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2013) that have been developed under the SPS Agreement (WTO 1995).

A PRA is ‘the process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it’ (FAO 2015a). A pest is ‘any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products’ (FAO 2015a).

Biosecurity risk consists of two major components: the probability of a pest entering, establishing and spreading in Australia from imports; and the consequences should this happen. These two components are combined to give an overall estimate of the risk.

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that, on arrival in Australia, the department will verify that the consignment received is as described on the commercial documents and its integrity has been maintained.

Restricted risk is estimated with phytosanitary measure(s) applied. A phytosanitary measure is ‘any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests’ (FAO 2015a).

A glossary of the terms used in this risk analysis is provided at the back of this report.

The PRAs are conducted in the following three consecutive stages: initiation, pest risk assessment and pest risk management.

2.1 Stage 1 Initiation

Initiation identifies the pest(s) and pathway(s) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

Appendix A of this risk analysis report lists the pests with the potential to be associated with the exported commodity produced using commercial production and packing procedures. Appendix A does not present a comprehensive list of all the pests associated with the entire plant, but concentrates on the pests that could be on the assessed commodity. Contaminating pests that have no specific relation to the commodity or the export pathway have not been listed and would be addressed by Australia’s current approach to contaminating pests.

The identity of the pests is given in Appendix A. The species name is used in most instances but a lower taxonomic level is used where appropriate. Synonyms are provided where the current scientific name differs from that provided by the exporting country’s National Plant Protection Organisation (NPPO) or where the cited literature used a different scientific name.

For this risk analysis, the ‘PRA area’ is defined as Australia for pests that are absent, or of limited distribution and under official control. For areas with regional freedom from a pest, the ‘PRA

area' may be defined on the basis of a state or territory of Australia or may be defined as a region of Australia consisting of parts of a state or territory or several states or territories.

For pests that had been considered by the department in other risk assessments and for which import policies already exist, a judgement was made on the likelihood of entry of pests on the commodity and whether existing policy is adequate to manage the risks associated with its import. Where appropriate, the previous risk assessment was taken into consideration when developing the new policy.

2.2 Stage 2 Pest risk assessment

A pest risk assessment (for quarantine pests) is the 'evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences' (FAO 2015a).

The following three, consecutive steps were used in pest risk assessment:

2.2.1 Pest categorisation

Pest categorisation identifies which of the pests with the potential to be on the commodity are quarantine pests for Australia and require pest risk assessment. A 'quarantine pest' is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2015a).

The pests identified in Stage 1 were categorised using the following primary elements to identify the quarantine pests for the commodity being assessed:

- identity of the pest
- presence or absence in the PRA area
- regulatory status
- potential for establishment and spread in the PRA area
- potential for economic consequences (including environmental consequences) in the PRA area.

The results of pest categorisation are set out in Appendix A. The quarantine pests identified during categorisation were carried forward for pest risk assessment and are listed in Tables 4.1 to 4.4.

2.2.2 Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2013). A summary of this process is given below, followed by a description of the qualitative methodology used in this risk analysis.

Probability of entry

The probability of entry describes the probability that a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state in the PRA area and subsequently be transferred to a host. It is based on pathway scenarios depicting necessary steps in the sourcing of the commodity for export, its processing, transport and storage, its use in Australia and the generation and disposal of waste. In particular, the ability of the pest to survive is considered for each of these various stages.

The probability of entry estimates for the quarantine pests for a commodity are based on the use of the existing commercial production, packaging and shipping practices of the exporting country. Details of the existing commercial production practices for the commodity are set out in Chapter 3. These practices are taken into consideration by the department when estimating the probability of entry.

For the purpose of considering the probability of entry, the department divides this step into two components:

- **Probability of importation**—the probability that a pest will arrive in Australia when a given commodity is imported.
- **Probability of distribution**—the probability that the pest will be distributed, as a result of the processing, sale or disposal of the commodity, in the PRA area and subsequently transfer to a susceptible part of a host.

Factors to be considered in the probability of importation may include:

- distribution and incidence of the pest in the source area
- occurrence of the pest in a life-stage that would be associated with the commodity
- mode of trade (for example, bulk, packed)
- volume and frequency of movement of the commodity along each pathway
- seasonal timing of imports
- pest management, cultural and commercial procedures applied at the place of origin
- speed of transport and conditions of storage compared with the duration of the lifecycle of the pest
- vulnerability of the life-stages of the pest during transport or storage
- incidence of the pest likely to be associated with a consignment
- commercial procedures (for example, refrigeration) applied to consignments during transport and storage in the country of origin, and during transport to Australia.

Factors to be considered in the probability of distribution may include:

- commercial procedures (for example, refrigeration) applied to consignments during distribution in Australia
- dispersal mechanisms of the pest, including vectors, to allow movement from the pathway to a host
- whether the imported commodity is to be sent to a few or many destination points in the PRA area
- proximity of entry, transit and destination points to hosts
- time of year at which import takes place
- intended use of the commodity (for example, for planting, processing or consumption)
- risks from by-products and waste.

Probability of establishment

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO 2015a). In order to estimate the probability of establishment of a pest, reliable

biological information (for example, lifecycle, host range, epidemiology, survival) is obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the probability of establishment.

Factors to be considered in the probability of establishment in the PRA area may include:

- availability of hosts, alternative hosts and vectors
- suitability of the environment
- reproductive strategy and potential for adaptation
- minimum population needed for establishment
- cultural practices and control measures.

Probability of spread

Spread is defined as ‘the expansion of the geographical distribution of a pest within an area’ (FAO 2015a). The probability of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas. In order to estimate the probability of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the probability of spread.

Factors to be considered in the probability of spread may include:

- suitability of the natural and/or managed environment for natural spread of the pest
- presence of natural barriers
- potential for movement with commodities, conveyances or by vectors
- intended use of the commodity
- potential vectors of the pest in the PRA area
- potential natural enemies of the pest in the PRA area.

Assigning qualitative likelihoods for entry, establishment and spread

In its qualitative PRAs, the department uses the term ‘likelihood’ for the descriptors it uses for its estimates of probability of entry, establishment and spread. Qualitative likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 2.1). Descriptive definitions for these descriptors and their indicative probability ranges are given in Table 2.1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors and are not used beyond this purpose in qualitative PRAs. These indicative probability ranges provide guidance to the risk analyst and promote consistency between different pest risk assessments.

Table 2.1 Nomenclature of qualitative likelihoods

Likelihood	Descriptive definition	Indicative range
High	The event would be very likely to occur	$0.7 < to \leq 1$
Moderate	The event would occur with an even likelihood	$0.3 < to \leq 0.7$
Low	The event would be unlikely to occur	$0.05 < to \leq 0.3$
Very low	The event would be very unlikely to occur	$0.001 < to \leq 0.05$
Extremely low	The event would be extremely unlikely to occur	$0.000001 < to \leq 0.001$
Negligible	The event would almost certainly not occur	$0 < to \leq 0.000001$

The likelihood of entry is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 2.2). This matrix is then used to combine the likelihood of entry and the likelihood of establishment, and the likelihood of entry and establishment is then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread.

For example, if the likelihood of importation is assigned a descriptor of 'low' and the likelihood of distribution is assigned a descriptor of 'moderate', then they are combined to give a likelihood of 'low' for entry. The likelihood for entry is then combined with the likelihood assigned for establishment of 'high' to give a likelihood for entry and establishment of 'low'. The likelihood for entry and establishment is then combined with the likelihood assigned for spread of 'very low' to give the overall likelihood for entry, establishment and spread of 'very low'. This can be summarised as:

importation x distribution = entry [E]

low x moderate = low

entry x establishment = [EE]

low x high = low

[EE] x spread = [EES]

low x very low = very low

Table 2.2 Matrix of rules for combining qualitative likelihoods

	High	Moderate	Low	Very low	Extremely low	Negligible
High	High	Moderate	Low	Very low	Extremely low	Negligible
Moderate		Low	Low	Very low	Extremely low	Negligible
Low			Very low	Very low	Extremely low	Negligible
Very low				Extremely low	Extremely low	Negligible
Extremely low					Negligible	Negligible
Negligible						Negligible

Time and volume of trade

One factor affecting the likelihood of entry is the volume and duration of trade. If all other conditions remain the same, the overall likelihood of entry will increase as time passes and the overall volume of trade increases.

The department normally considers the likelihood of entry on the basis of the estimated volume of one year's trade. This is a convenient value for the analysis that is relatively easy to estimate and allows for expert consideration of seasonal variations in pest presence, incidence and behaviour to be taken into account. The consideration of the likelihood of entry, establishment and spread and subsequent consequences takes into account events that might happen over a number of years even though only one year's volume of trade is being considered. This difference reflects biological and ecological facts, for example where a pest or disease may establish in the year of import but spread may take many years.

The use of a one year volume of trade has been taken into account when setting up the matrix that is used to estimate the risk and therefore any policy based on this analysis does not simply apply to one year of trade. Policy decisions that are based on the department's method that uses the estimated volume of one year's trade are consistent with Australia's policy on appropriate level of protection and meet the Australian Government's requirement for ongoing quarantine protection. If there are substantial changes in the volume and nature of the trade in specific commodities then the department will review the risk analysis and, if necessary, provide updated policy advice.

In assessing the volume of trade in this risk analysis, the department assumed that a substantial volume of trade will occur.

2.2.3 Assessment of potential consequences

The objective of the consequence assessment is to provide a structured and transparent analysis of the likely consequences if the pests or disease agents were to enter, establish and spread in Australia. The assessment considers direct and indirect pest effects and their economic and environmental consequences. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO 1995), ISPM 5 (FAO 2015a) and ISPM 11 (FAO 2013).

Direct pest effects are considered in the context of the effects on:

- plant life or health
- other aspects of the environment.

Indirect pest effects are considered in the context of the effects on:

- eradication, control
- domestic trade
- international trade
- environment.

For each of these six criteria, the consequences were estimated over four geographic levels, defined as:

Local—an aggregate of households or enterprises (a rural community, a town or a local government area).

District—a geographically or geopolitically associated collection of aggregates (generally a recognised section of a state or territory, such as ‘Far North Queensland’).

Regional—a geographically or geopolitically associated collection of districts in a geographic area (generally a state or territory, although there may be exceptions with larger states such as Western Australia).

National—Australia wide (Australian mainland states and territories and Tasmania).

For each criterion, the magnitude of the potential consequence at each of these levels was described using four categories, defined as:

Indiscernible—pest impact unlikely to be noticeable.

Minor significance—expected to lead to a minor increase in mortality/morbidity of hosts or a minor decrease in production but not expected to threaten the economic viability of production. Expected to decrease the value of non-commercial criteria but not threaten the criterion’s intrinsic value. Effects would generally be reversible.

Significant—expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible.

Major significance—expected to threaten the economic viability through a large increase in mortality/morbidity of hosts, or a large decrease in production. Expected to severely or irreversibly damage the intrinsic ‘value’ of non-commercial criteria.

The estimates of the magnitude of the potential consequences over the four geographic levels were translated into a qualitative impact score (A-G) using Table 2.3. For example, a consequence with a magnitude of ‘significant’ at the ‘district’ level will have a consequence impact score of D.

Table 2.3 Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographic scales

Magnitude	Geographic scale			
	Local	District	Region	Nation
Indiscernible	A	A	A	A
Minor significance	B	C	D	E
Significant	C	D	E	F
Major significance	D	E	F	G

Note: In earlier qualitative PRAs, the scale for the impact scores went from A to F and did not explicitly allow for the rating 'indiscernible' at all four levels. This combination might be applicable for some criteria. In this report, the impact scale of A to F has been changed to become B-G and a new lowest category A ('indiscernible' at all four levels) was added. The rules for combining impacts in Table 2.4 were adjusted accordingly.

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules (Table 2.4). These rules are mutually exclusive, and are assessed in numerical order until one applies.

Table 2.4 Decision rules for determining the overall consequence rating for each pest

Rule	The impact scores for consequences of direct and indirect criteria	Overall consequence rating
1	Any criterion has an impact of 'G'; or more than one criterion has an impact of 'F'; or a single criterion has an impact of 'F' and each remaining criterion an 'E'.	Extreme
2	A single criterion has an impact of 'F'; or all criteria have an impact of 'E'.	High
3	One or more criteria have an impact of 'E'; or all criteria have an impact of 'D'.	Moderate
4	One or more criteria have an impact of 'D'; or all criteria have an impact of 'C'.	Low
5	One or more criteria have an impact of 'C'; or all criteria have an impact of 'B'.	Very Low
6	One or more but not all criteria have an impact of 'B', and all remaining criteria have an impact of 'A'.	Negligible

2.2.4 Estimation of the unrestricted risk

Once the assessment of the likelihood of entry, establishment and spread and for potential consequences are completed, the unrestricted risk can be determined for each pest or groups of pests. This is determined by using a risk estimation matrix (Table 2.5) to combine the estimates of the probability of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the combination of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (for example, low, moderate, high) but the vertical axis refers to likelihood and the horizontal axis refers to consequences. Accordingly, a 'low' likelihood combined with 'high' consequences, is not the same as a 'high' likelihood combined with 'low' consequences—the matrix is not symmetrical. For example, the former combination would give an unrestricted risk rating of 'moderate', whereas, the latter would be rated as a 'low' unrestricted risk.

Table 2.5 Risk estimation matrix

Likelihood of pest entry, establishment and spread	Consequences of pest entry, establishment and spread					
	Negligible	Very low	Low	Moderate	High	Extreme
High	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Moderate	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Low	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
Very low	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
Negligible	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

2.2.5 Australia's appropriate level of protection (ALOP)

The SPS Agreement defines the concept of an 'appropriate level of sanitary or phytosanitary protection (ALOP)' as the level of protection deemed appropriate by the WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Like many other countries, Australia expresses its ALOP in qualitative terms. The ALOP for Australia, which reflects community expectations through government policy, is currently expressed as providing a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero. The band of cells in Table 2.5 marked 'very low risk' represents the ALOP for Australia.

2.3 Stage 3 Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve the ALOP for Australia, while ensuring that any negative effects on trade are minimised.

The conclusions from pest risk assessment are used to decide whether risk management is required and if so, the appropriate measures to be used. Where the unrestricted risk estimate does not achieve the ALOP for Australia, risk management measures are required to reduce this risk to a very low level. The guiding principle for risk management is to manage risk to achieve the ALOP for Australia. The effectiveness of any proposed phytosanitary measures (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure it reduces the restricted risk for the relevant pest or pests to meet the ALOP for Australia.

ISPM 11 (FAO 2013) provides details on the identification and selection of appropriate risk management options and notes that the choice of measures should be based on their effectiveness in reducing the likelihood of entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments—for example, inspection or testing for freedom from pests, prohibition of parts of the host, a pre-entry or post-entry quarantine system, specified conditions on preparation of the consignment, specified treatment of the consignment, restrictions on end-use, distribution and periods of entry of the commodity
- options preventing or reducing infestation in the crop—for example, treatment of the crop, restriction on the composition of a consignment so it is composed of plants belonging to resistant or less susceptible species, harvesting of plants at a certain age or specified time of the year, production in a certification scheme
- options ensuring that the area, place or site of production or crop is free from the pest—for example, pest-free area, pest-free place of production or pest-free production site
- options for other types of pathways—for example, consider natural spread, measures for human travellers and their baggage, cleaning or disinfestations of contaminated machinery
- options within the importing country—for example, surveillance and eradication programs
- prohibition of commodities—if no satisfactory measure can be found.

Risk management measures are identified for each quarantine pest where the risk does not achieve the ALOP for Australia. These are presented in Chapter 5: Pest risk management, of this report.

3 Korea's commercial production practices for strawberries

This chapter provides information on the pre-harvest, harvest and post-harvest practices, considered to be standard practices in Korea for the production of strawberries for export. The export capability of Korea is also outlined.

3.1 Assumptions used in estimating unrestricted risk

Korea provided Australia with information on the standard commercial practices used in the production of strawberries in different regions of Korea. The information covers all commercially produced strawberry cultivars in Korea and is limited to production in greenhouses. This information was complemented with data from other sources and has been taken into consideration when estimating the unrestricted risks of pests that may be associated with the import of this commodity.

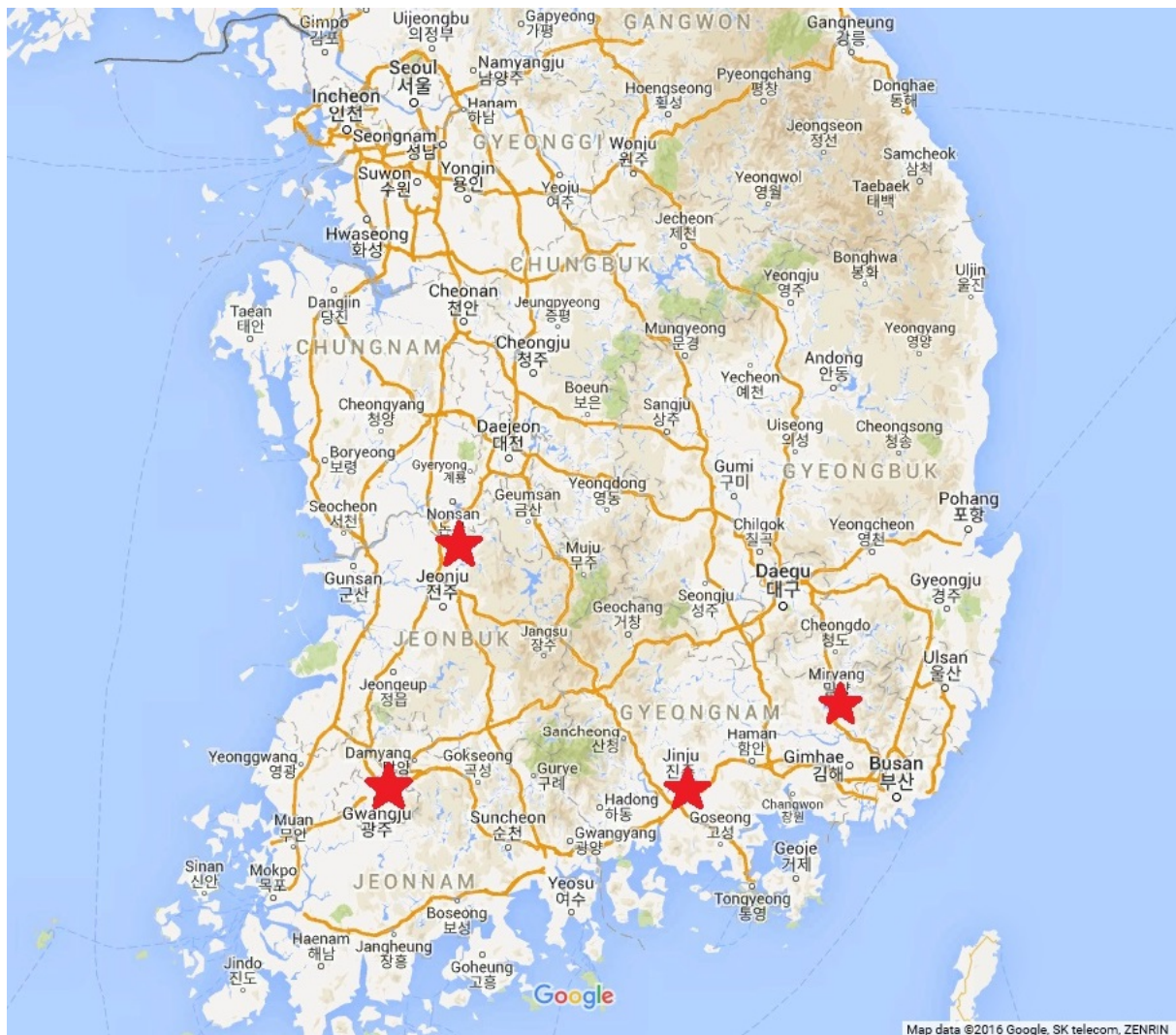
Officers from the department visited strawberry greenhouse production areas in Korea in March 2016, to verify the pest status and observe harvest and packing procedures for the export of strawberries. The department's observations and additional information provided during the visit confirmed the production and processing procedures described in this chapter as standard commercial greenhouse production practices for strawberries for export.

In estimating the likelihood of pest introduction it was assumed that the pre-harvest, harvest and post-harvest production practices for strawberries, as described in this chapter, are implemented for all regions and for all strawberry cultivars within the scope of this analysis. Where a specific practice described in this chapter is not taken into account to estimate the unrestricted risk, it is clearly identified and explained in Chapter 4.

3.2 Climate in production areas

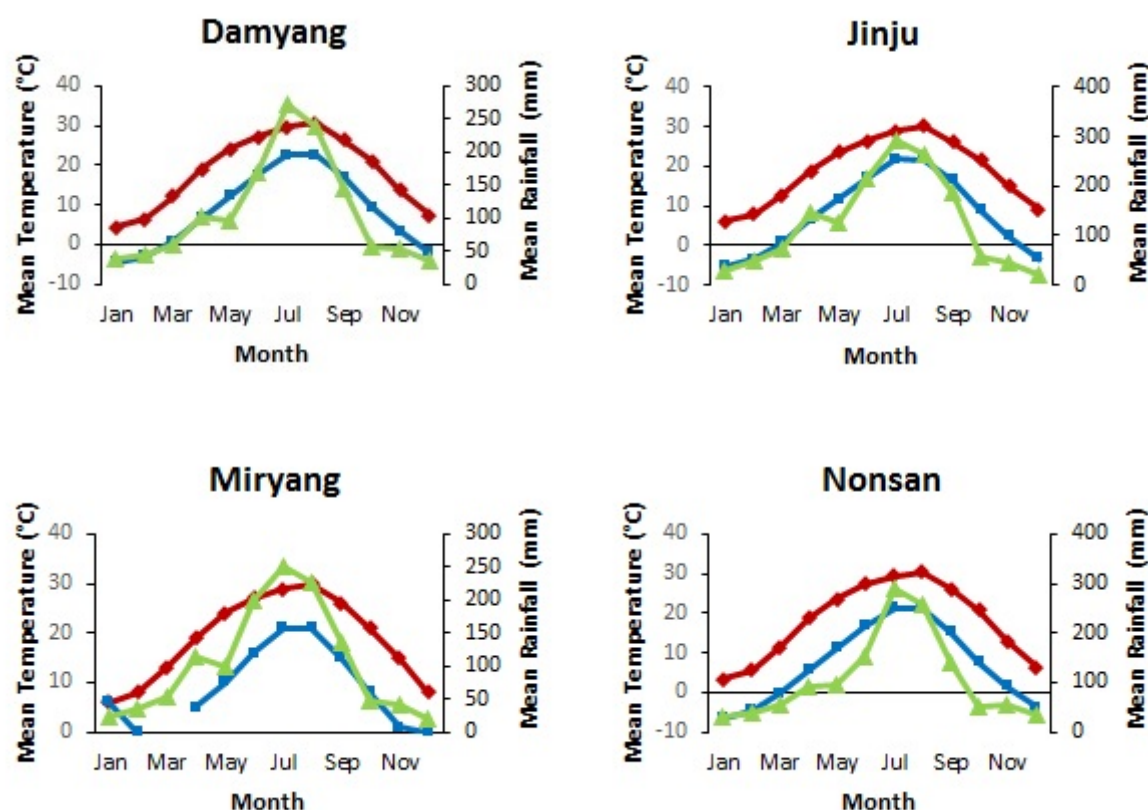
The major strawberry growing regions in Korea are Gyeongsangnam-do (accounting for 34 per cent of total production) and Chungcheongnam-do (32 per cent), followed by Jeollanam-do (10 per cent) and Jeollabuk-do (nine per cent). The cities of Jinju and Miryang (in Gyeongsangnam-do), Nonsan (in Chungcheongnam-do), and the county Damyang (in Jeollanam-do) account for up to 35 per cent of Korea's total strawberry production (QIA 2015b). In Map 3 the main strawberry production areas are depicted.

Korea has a temperate climate. Winters in Korea are typically characterised by snow and low temperatures; spring is mild, dry and clear; summers are warm, humid with heavy rainfall and typhoons; and autumn is dry and clear, with some heavy rainfall through September (KMA 2011). Figure 2 summarises the annual mean maximum and minimum temperatures as well as precipitation in the cities of Jinju, Miryang and Nonsan and in the Damyang county.

Map 3 Main strawberry production areas in Korea

Based on information provided by QIA (2015b)

Figure 2 Monthly maximum and minimum temperatures and mean rainfall climate data in strawberry production areas of Korea



Monthly mean maximum (—◆—) and minimum (—■—) temperatures (°C) and mean monthly rainfall (millimetres) (—▲—) from climate data collected in 2015 (Climate-data.org 2015) in strawberry production areas of the county Damyang and the cities of Jinju, Miryang and Nonsan, in Korea

3.3 Pre-harvest

3.3.1 Cultivars

The main strawberry cultivars grown in Korea are Maehyang, Akihime, Seol-hyang, Seonhong, and Flamengo (QIA 2015b). Of these, Maehyang and Flamengo are the main export cultivars and it is expected that these are the main cultivars Korea intends to export to Australia. The characteristics of these two cultivars are described below.

Maehyang

The fruit of the Maehyang cultivar is long and oval in shape. The average weight is 15 grams. It has a comparatively high sugar content, with soluble solids at an average of 11.4 degrees Brix (QIA 2015b).

Flamengo

Whilst the shape and weight of the fruit is similar to the Maehyang cultivar, Flamengo fruit has a lower sugar content and therefore has a more sour taste, with soluble solids at an average of 9.4 degrees Brix (QIA 2015b).

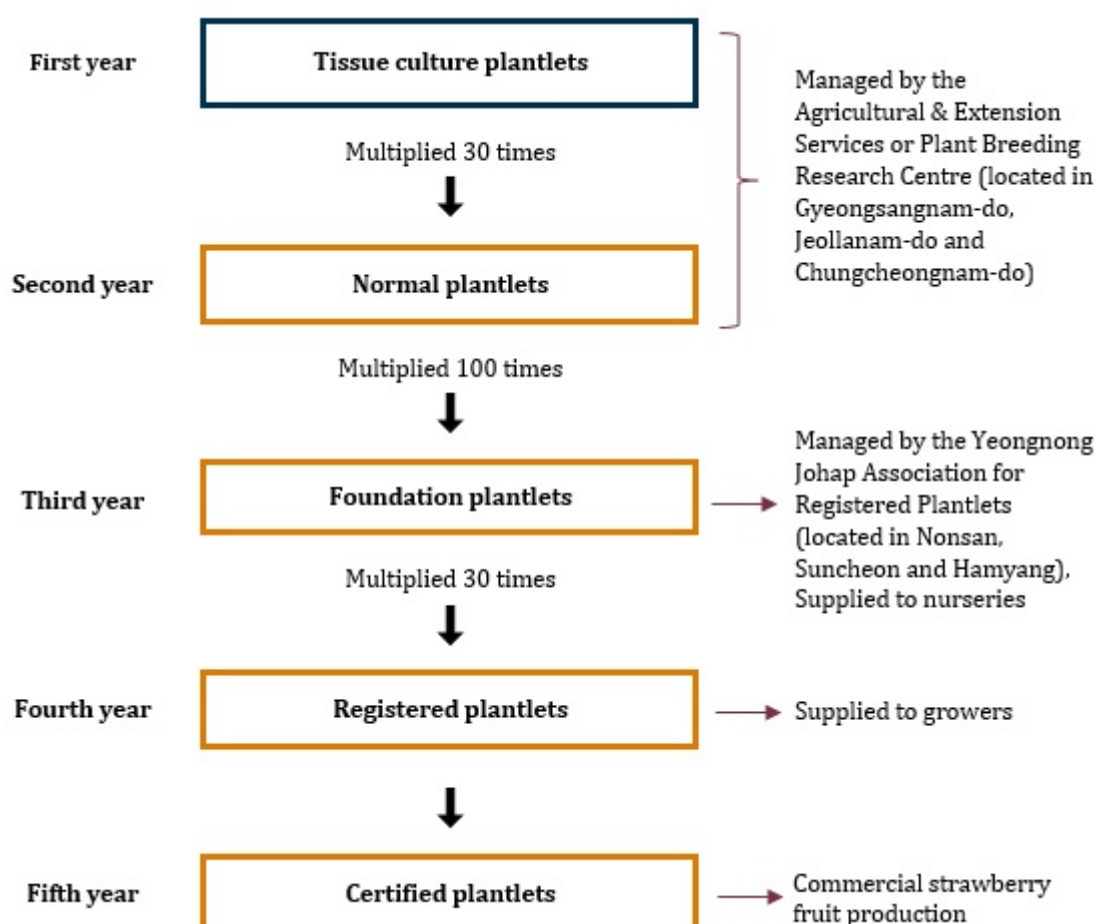
3.3.2 Cultivation practices

Production of registered plantlets

Strawberry fruit in Korea is harvested from the progeny of 'registered' plantlets, which are supplied by the Yeongnong Johap Association for Registered Plantlets to nurseries. The production process for registered plantlets is detailed below.

First, plantlets are grown from tissue culture, and in their first year, they are tested for virus freedom as detailed later in this section. In the second year, healthy plantlets are each multiplied 30 times, and in the third year, their progeny are each multiplied a further 100 times. The resulting plants, known as foundation plantlets, are supplied to specialised nurseries, who multiply each plantlet a further 30 times in the fourth year. The resulting plantlets are the registered plants supplied to growers, who perform their own multiplication in the fifth year to produce certified plantlets, which are then used for strawberry fruit production. The entire process is summarised in Figure 3.

Figure 3 Schedule for production of certified plantlets



The progression from plants grown in tissue culture to plants producing commercial strawberries takes five years in total. A rolling production system is in place; newly grown tissue cultured strawberry plants are produced every year, in order to ensure a fresh supply of registered plants for commercial production sites.

Multiplication process

The multiplication process occurs in greenhouses using a hydroponics system (Figures 4 and 5).

After a plant is planted, runners grow from the plant sideways, and in a suitable place, take root to form new self-sustaining plants ('daughter' plants). Once established, a daughter plant also grows runners, which go on to form more daughter plants. The hydroponics system used is built specifically to facilitate this, and the arrangement of plants for the multiplication process in greenhouses is shown in Figures 4 and 5.

Figure 4 Hydroponics system set up to facilitate strawberry plant multiplication

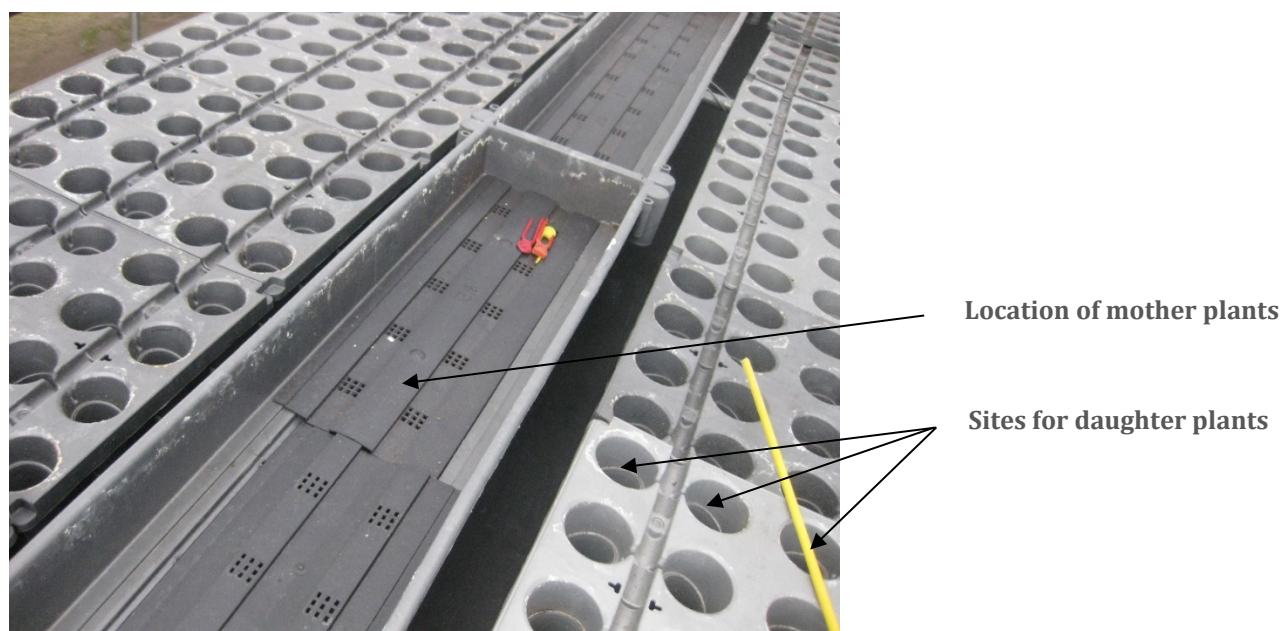
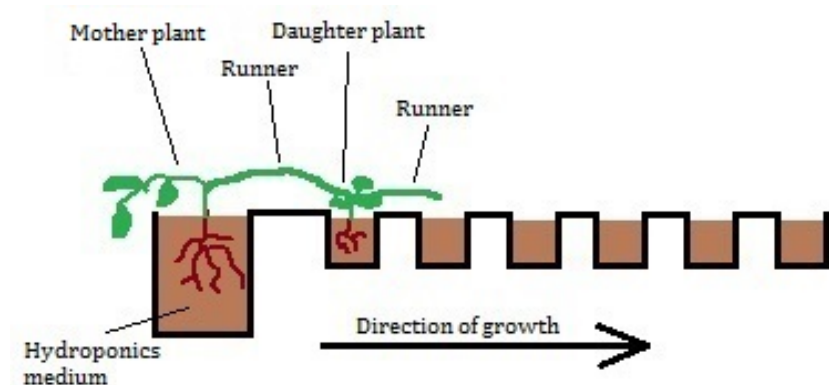


Figure 5 Layout for multiplication of registered plants



Daughter plants of registered plants (certified plantlets) grown in this system are then cut and used for strawberry fruit production. Multiplication of strawberry plants and production of strawberry fruit occur in separate greenhouses. Methods for strawberry fruit production are described below.

Greenhouse strawberry fruit production

In Korea, 97 per cent of strawberries are produced in greenhouses (QIA 2015b). An intrinsic benefit of greenhouse strawberry production is that temperature can be manipulated, which allows for control of strawberry growth. Plants may be grown either hydroponically or in soil.

Hydroponically grown strawberries

In greenhouses that use a hydroponic system, elevated bed systems are generally used. Beds are spaced between 90 and 120 centimetres apart, with two rows of plants in each bed, 20-25 centimetres apart, as shown in Figure 6. Spacing between plants within a row is 18-20 centimetres (Figure 6). Both single-layered bed systems and double-layered bed systems, where one bed is stacked on top of another (Figure 7), are used.

Soil grown strawberries

In soil grown strawberries, the soil is covered by plastic which prevents contact with the fruit. The soil is also fumigated, to manage soilborne pests. The beds are also between 90 and 120 centimetres apart.

Three cultivation methods are used, and these methods are outlined below.

Figure 6 Arrangement of strawberry plants in greenhouse production

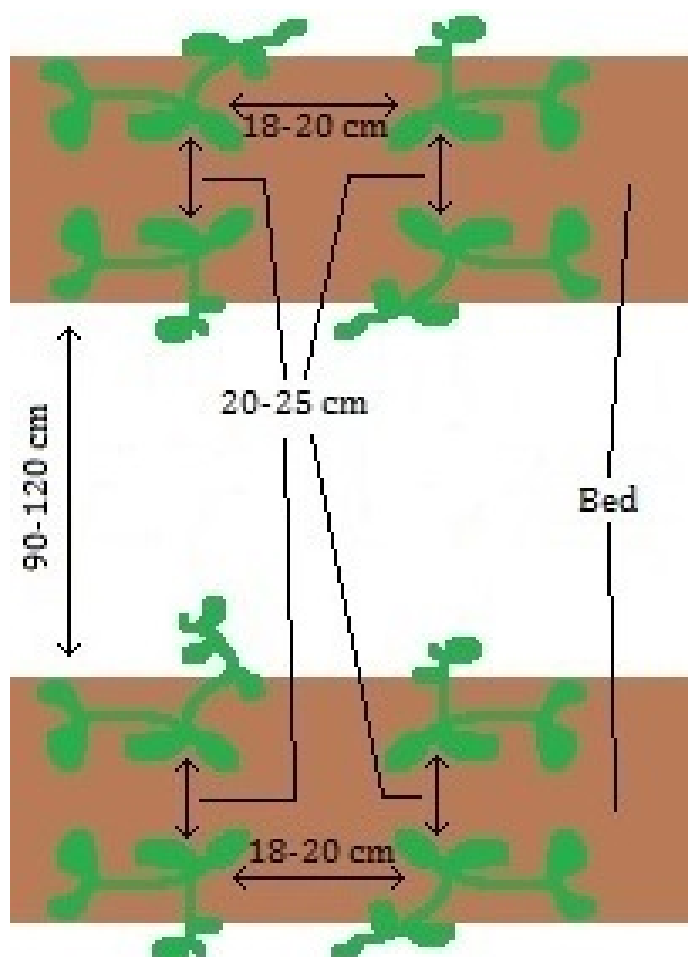


Figure 7 Layout of stacked-bed production*Semi-forcing culture*

After flower bud differentiation, induced by dropping temperatures in mid to late September, the plants enter a dormant period. They are then stimulated to grow in December, by increasing the temperature, and fruits are harvested from February through May (QIA 2015b).

Forcing culture

After flower bud differentiation, again induced by dropping temperatures in mid to late September, plants are grown immediately, by increasing the temperature, and the earlier warm temperatures lead to a much shorter, or complete lack of, a dormant period. This leads to an earlier fruit harvest, from December through March (QIA 2015b).

Super-forcing culture

Flower bud differentiation is brought about in early August, by exposing plants to artificial cold conditions, using either cold water treatment or by exposing plants to colder night temperatures. The plants are then planted and kept heated in greenhouses, as with forced culture plants. The earlier flower bud differentiation leads to a much earlier fruit harvest, from October to November (QIA 2015b).

Pest management

Tissue culture plantlets are screened for viruses. The viruses tested for and the test procedures used are shown in Table 3.1 (QIA 2015b):

Table 3.1 Viruses targeted by virus tests in tissue culture plantlets and the method of detection used

Virus	Methods
<i>Strawberry mottle virus</i>	RT-PCR
<i>Strawberry mild yellow edge virus</i>	ELISA, RT-PCR
<i>Arabic mosaic virus</i>	ELISA, RT-PCR
<i>Strawberry pallidosis associated virus</i>	RT-PCR
<i>Strawberry crinkle virus</i>	RT-PCR
<i>Strawberry vein banding virus</i>	PCR
<i>Strawberry necrotic spot virus</i>	ELISA, RT-PCR
<i>Strawberry latent ringspot virus</i>	ELISA, RT-PCR

Normal and foundation plantlets in the second and third year of the process follow the pest management schedule shown in the Table 3.2.

Table 3.2 Pest management schedule for second and third year foundation plantlets

Time of year	Pest/pathogen	Chemical spray	Number of applications
Early-April	anthracnose, grey mould rot	-Sporgon (fungicide; active ingredient prochloraz; leaves + soil drench) -Cabrio (fungicide; active ingredient Pyraclostrobin)	2
Late-April	anthracnose	-Antracol (fungicide; active ingredient Propineb)	1
Early-May		NaDCC (disinfectant; Sodium Dichloroisocyanurate) 1000×	
Late-May	anthracnose, wilt disease, aphids, mites	-Sporgon (leaves + soil drench) -Berry Mate (biopesticide; contains <i>Bacillus velezensis</i>) -All Star (insecticide; active ingredient Abamectin) -Setis (insecticide; active ingredient Flonicamid)	3
Early-June	anthracnose, aphids, mites	-Antracol -Mospilan (insecticide; active ingredient Acetamiprid) -Milbeknock (insecticide; active ingredient Milbemectin) + Zoom (insecticide; active ingredient Etoxazole)	3
Mid-June	aphids	Setis (Flonicamid)	1

Time of year	Pest/pathogen	Chemical spray	Number of applications
Late-June	anthracnose, aphids, mites	-Ortiva (fungicide; active ingredient Azoxystrobin) -Setis -Milbeknock + Zoom	3
Early-July	leaf beetles, anthracnose	-Steward Gold (insecticide; active ingredient Indoxacarb) -Sporgon	2
Mid-July	anthracnose, phytophthora blight, aphids	-Baybong (fungicide; biopesticide using <i>Bacillus subtilis</i> Y1336) -Forum (fungicide; active ingredient Dimethomorph) -Setis	2
Late-July	anthracnose, mites	-Cabrio -All Star -NaDCC	2
Early-August	anthracnose, moths	-Salimkkun (fungicide; active ingredient Metconazole) -Avata (insecticide; active ingredient Indoxacarb)	2
Mid-August	anthracnose, moths	-Sporgon -Steward Gold	2
Late-August	anthracnose, wilt disease	-Baybong	2
Early-September	anthracnose, moths	-Cabrio -Affirm (insecticide; active ingredient Emamectin benzoate)	2
Mid-September	anthracnose	-Baybong	1
Late-September	anthracnose	-Ortiva	1
Early-October	anthracnose, mites	-Salimkkun -All Star	2
Mid-October	mites, moth pests	-All Star -Steward Gold	2
Late-October	anthracnose	-Ortiva	1
Early-November	anthracnose	-Salimkkun	1
Mid-November	anthracnose, grey mould rot	-Cabrio -Gyunmori (fungicide; active ingredient Fenhexamid.iminoctadin tris[albesilate])	2
Late-November	anthracnose, grey mould rot	-Sporgon -Switch	2
Late-December	anthracnose, mites	-Sporgon -Milbeknock + Zoom	

In general, Korea uses an integrated pest management system for fruit production in greenhouses including the use of biological controls, such as the predatory mites *Phytoseiulus persimilis* and *Neoseiulus californicus* to control mites. Pest management programs

include preventative sprays, and monitoring programs. The control scheme for pests of strawberries is shown in Table 3.3 (QIA 2015b):

Table 3.3 Pest management schedule

Time of major pest occurrences	Pest species	Control strategy
March-June	wilt disease, slug, <i>Acusta despecta</i>	Only disease-free plantlets are used and hiding places for gastropods such as weeds and surrounding crops are removed
June	anthracnose, <i>Spodoptera litura</i> , <i>S. exigua</i>	Only disease-free plantlets are used, damaged fruits are removed, adult insects prevented entry by using insect-proof nets and chemical sprays are used
Occurs throughout the year	<i>Botrytis cinerea</i> , <i>Tetranychus urticae</i> , <i>T. kanzawai</i>	Preventative chemical sprays applied, and target bottom leaves of host plants (the main incursion area) with chemical control.
Occurs throughout the year	<i>Sphaerotheca aphanis</i> , <i>Aphis gossypii</i> , <i>A. forbesi</i> , <i>Chaetosiphon (Pentatrichopus) minor</i> , <i>Myzus persicae</i>	Apply chemical controls at the early stage of incursions and prevent entry of imagoes (mature adults) into greenhouses
Occurs throughout the year	<i>Mycosphaerella fragariae</i> , <i>Thrips palmi</i> , <i>Frankliniella occidentalis</i>	Apply chemical controls at the early stage of incursions
Occurs throughout the year	viral diseases, <i>Aphelenchoides fragariae</i> , <i>Pratylenchus</i> sp.	Virus free plantlets used, and plants are only cultivated in disease-free greenhouses and any runners affected are removed early on

Sticky traps are used to monitor the presence of flying pests in greenhouses.

Imported seedlings and seeds used for Korea's breeding programme

Imported seedlings are not a major part of strawberry production in Korea, with only about 0.2 per cent of runner daughter plants being imported. Out of imported daughter plants from 2013 to 2015, the majority were from China (46 per cent) followed by the Netherlands (29 per cent). The remaining were from France, United Kingdom, United States and Spain (QIA 2016).

Samples from each consignment of imported daughter plants are tested for the presence of bacteria and viruses shown in Table 3.4 (QIA 2016).

Table 3.4 Bacteria and Viruses targeted by tests for imported runner daughter plants

Pathogen type	Scientific name	Main test method
Bacterial	<i>'Candidatus Phlomobacter fragariae'</i>	Electron microscope
	<i>Xanthomonas fragariae</i>	ELISA
	<i>Rhodococcus fascians</i>	PCR, ELISA
	<i>Arabis mosaic virus</i>	PCR, ELISA
Viral	<i>Fragaria chiloensis virus</i>	Electron microscope
	<i>Raspberry ringspot virus</i>	PCR, ELISA
	<i>Strawberry latent ringspot virus</i>	PCR, ELISA
	<i>Tobacco necrosis virus</i>	PCR, ELISA
	<i>Tobacco streak virus</i>	PCR, ELISA
	<i>Tomato black ring virus</i>	PCR, ELISA
	<i>Tomato bushy stunt virus</i>	PCR, ELISA
	<i>Tomato ringspot virus</i>	PCR, ELISA

The samples are also subject to microscope inspections to determine the presence of insects and other invertebrates. Plant tissues that show the symptoms of fungal infection are incubated to encourage fungal growth and any resulting cultures identified using a microscope. The presence of nematodes is tested using a modified Baermann Funnel Method (Baermann 1917).

When seeds are imported, they are inspected by Korean officials for any sign of pests and pathogens, before laboratory tests of samples from each consignment. Samples are inspected using a microscope to detect arthropods. Fungi are detected via incubation of any culture that results from blots of the seeds. Viruses are detected via PCR/ELISA. In the period from 2013 to 2015, strawberry seeds were imported 11 times, for a total of 3.65 kilograms.

3.4 Harvesting and handling procedures

Strawberry fruit is harvested after 60 to 70 per cent colouration to allow for a longer transportation time as the fruits will continue to mature during the storage and transportation period (QIA 2015b).

Strawberries are picked individually by completely cutting off the peduncle, leaving only the calyx on the fruit, in order to prevent damage to other fruit during transport and when packaged in punnets.

3.5 Post-harvest

Fruits are packed on the same day they are harvested. Fruits are transported to packing houses in plastic tubs, crates, or baskets (an example is shown in Figure 8), by trucks.

Figure 8 Basket containing freshly harvested strawberries

3.5.1 Packing house

All strawberries for export are packed in packing houses. Sorting occurs here, and deformed or injured fruits are removed at this step. Fruit is then graded according to quality and size standards set by the National Agricultural Products Quality Management Service, shown in Tables 3.5 and 3.6 (QIA 2015b).

Table 3.5 Strawberry quality standards

Factor	Super-premium	Premium	Good
Evenness	No more than 10 per cent difference in weight	No more than 20 per cent difference in weight	Those that fail to meet Super-premium and Premium grades
Weight	More than 17 grams	More than 12 grams	Not applied
Colour	Shows excellent colour for its variety	Shows good colour for its variety	Those that fail to meet Super-premium and Premium grades
Sugar content	At least 11 degrees Brix	At least nine degrees Brix	Not applied
Freshness	Must have glossy surface	Must have glossy surface	Not applied
Slight defects	Less than five per cent	Less than 10 per cent	Less than 20 per cent

Table 3.6 Strawberry size standards

Grade	2L	L	M	S
Weight of strawberry	More than 25 grams	Between 17 and 25 grams	Between 12 and 17 grams	Less than 12 grams

After this step, they are packed by hand into plastic punnets with a capacity of typically either 250 or 500 grams, and packed punnets are placed on a conveyor belt as shown in Figure 9. Packers wear gloves during operations.

Figure 9 Strawberry sorting and packing process

The punnets are then packed into cardboard boxes which carry typically either eight 250 gram punnets or four 500 gram punnets, shown in Figures 10 and 11.

Figure 10 Box with eight 250 gram punnets of strawberries

Figure 11 Box with four 500 gram punnets of strawberries

If there is a surplus of supply, fruits may be kept in cold storage facilities at the packing house. Fruits are first kept at 3 °C for 24 hours, then at 7 °C for the remainder of the cold storage (QIA 2015b).

Export procedures

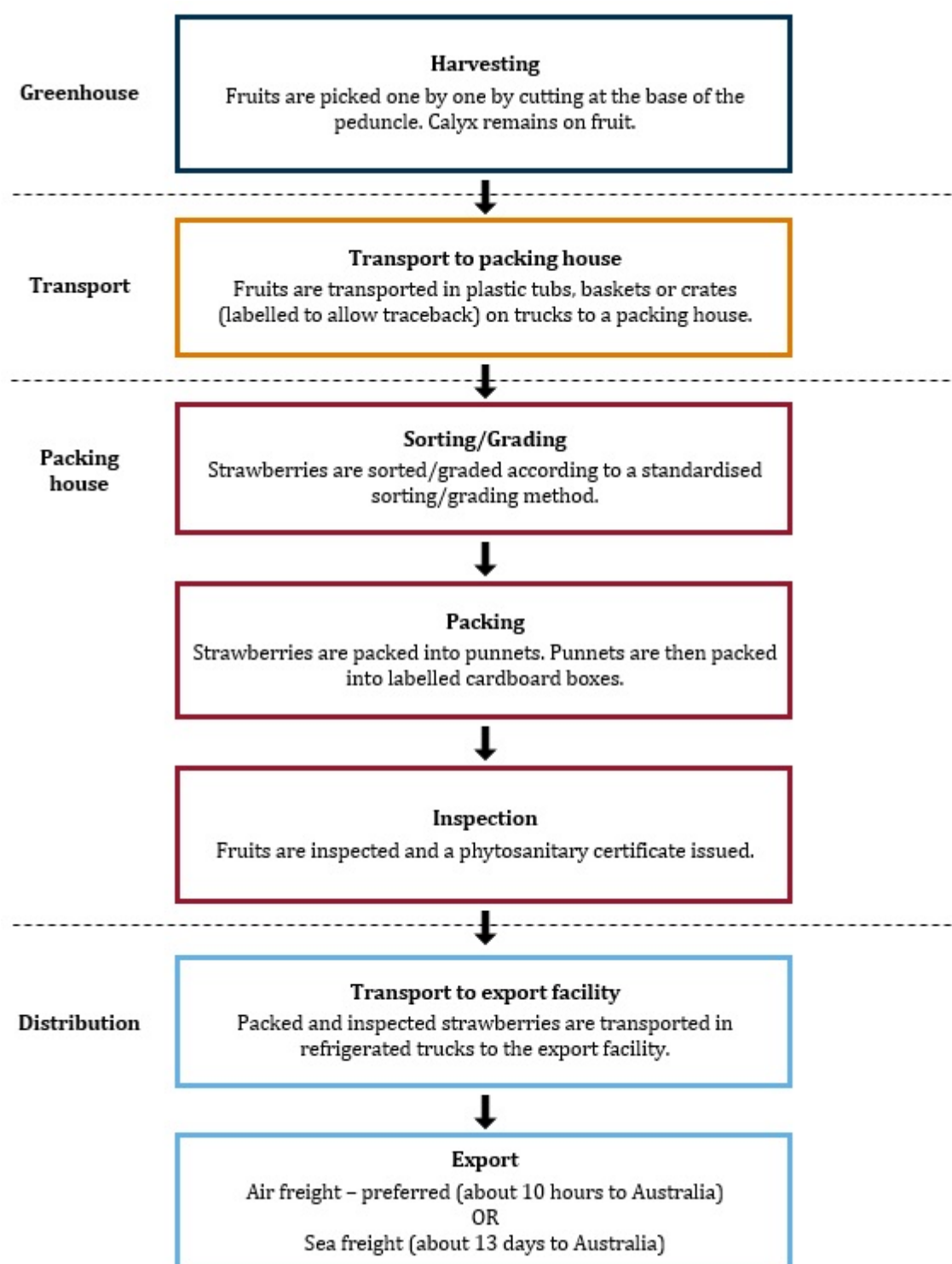
Prior to export, samples from each consignment are randomly inspected by personnel approved by Korea's Animal and Plant Quarantine Agency (QIA) at the packing house. If the consignment is found to be free of pests and meets the requirements of the importing country and is found free of pests, it is issued a phytosanitary certificate.

3.5.2 Transport

Consignments issued with a phytosanitary certificate are wrapped in plastic to prevent contamination post-inspection and are loaded into refrigerated trucks for transport to the export facility or kept in a separate storage facility at the packing house. The majority of strawberries for export will be transported by air freight, although some may be transported by sea freight. Air freight to Australia takes approximately 10 hours, and no temperature controls are in place since temperatures in the aircraft cargo hold are naturally low. Sea freight to Australia takes approximately 13 days and consignments are refrigerated.

Figure 12 summarises the operational steps from harvesting to export for Korean strawberries.

Figure 12 Summary of operational steps for strawberries grown in Korea for export



3.6 Export capability

3.6.1 Production statistics

Most of Korea's strawberry production is for domestic consumption. For example, in 2013 a total of 196,680 tonnes of strawberries were produced (QIA 2015b), of which only 2553 tonnes were exported (International Trade Centre 2015). The area dedicated to strawberry production is shown in Table 3.7.

Table 3.7 Area dedicated to strawberry production in Korea

Region	Production area (hectares)
Gyeongsangnam-do	2,383
Chungcheongnam-do	2,258
Jeollanam-do	707
Jeollabuk-do	631
Gyeongsangbuk-do	390
Others	521
Total	6890

3.6.2 Export statistics

Korean strawberry exports have been increasing during the recent years from 2553 tonnes in 2013, to 2780 tonnes in 2014, and 3005 tonnes in 2015 (International Trade Centre 2015). A breakdown of Korea's strawberry exports by destination country in 2015 is shown in Table 3.8.

Table 3.8 Amount of Korean strawberries exported to destination country in 2015

Nation	Volume (tonnes)
Hong Kong, China	1200
Singapore	982
Malaysia	377
Thailand	280
Mongolia	35
Indonesia	34
Japan	30
United States Minor Outlying Islands	19
Russian Federation	18
Taiwan	15
United Arab Emirates	4
Myanmar	4
Cambodia	4
Canada	2
Vietnam	1
Total	3005

3.6.3 Export season

Strawberry harvest occurs from October (super-forcing culture) through to May (semi-forcing culture), depending on the method of cultivation in greenhouses. However, the bulk of harvesting for exports of strawberries occurs from January to March.

4 Pest risk assessments for quarantine pests

Quarantine pests associated with strawberries in Korea are identified in the pest categorisation process (Appendix A). This chapter assesses the likelihood of the entry (importation and distribution), establishment and spread of these pests and the economic, including environmental, consequences these pests may cause if they were to enter, establish and spread in Australia.

Pest categorisation identified seven quarantine pests associated with strawberries from Korea. Tables 4.1 to 4.4 identify these quarantine pests. Of these, five pests are of national concern and two are of regional concern. Full details of the pest categorisation are given in Appendix A.

Assessments of risks associated with these seven pests are presented in this chapter. These pests have previously been evaluated by the department. The outcomes of previous assessments have been adopted where appropriate. Further explanation about the adoption of the outcomes of previous assessments is outlined below.

The likelihood of establishment and of spread of a pest in the PRA area will be comparable regardless of the fresh fruit commodity/country pathway in which the pest is imported into Australia, as these likelihoods relate specifically to events that occur in the PRA area and are independent of the importation pathway. The consequences of a pest are also independent of the importation pathway. For pests that have been assessed previously, the department reviewed the latest literature. If there is no new information available that would significantly change the likelihood ratings for establishment and for spread, and the consequences the pests may cause, the ratings given in the previous assessments for these components will be adopted.

The need to reassess the likelihood of distribution for pests that have been assessed previously is considered on a case-by-case basis by comparing factors relevant to the distribution of strawberries from Korea with those assessed previously. These factors include the commodity type, time of year at which import takes place and availability and susceptibility of hosts during the time of import. After comparing these factors and reviewing the latest literature, the ratings of likelihood of distribution from the previous assessments will be adopted if the department considers that the likelihood of distribution for strawberries from Korea would be comparable to that given in the previous assessments.

The need to reassess the likelihood of importation for pests that have been assessed previously is also considered on a case-by-case basis by comparing factors relevant to the importation of strawberries from Korea with those assessed previously. These factors include the commodity type, prevalence of the pest and commercial production practices. After comparing these factors and reviewing the latest literature, the department considers it appropriate not to reassess the likelihood of importation where a) there is no information to suggest that the likelihood of importation for strawberries from Korea is not comparable to those assessed previously, or b) changes in the likelihood rating for importation will not change the overall outcome, that is the unrestricted risk estimate (URE) of achieving or not achieving the ALOP for Australia.

The URE of achieving or not achieving the ALOP for Australia will be adopted for pests for which the reassessment of both the likelihood of importation and the likelihood of distribution is considered not necessary because the URE outcome would not change from the previous assessment (Table 4.2).

Table 4.3 lists the pests for which the department considers that the differences in the information relating to the likelihood of importation is sufficient to warrant the reassessment of this component. The remaining likelihood ratings and consequence estimates are adopted from previous assessments.

In addition, the quarantine risks posed by *Drosophila suzukii* from all countries and for all commodities, including strawberries, were previously assessed in the final pest risk analysis report for *Drosophila suzukii* (Department of Agriculture 2013). Therefore, there is no need to reassess this pest here (Table 4.4). A summary of pest information and the likelihood ratings and consequence estimates from the final PRA report for *D. suzukii* is presented in this chapter for convenience.

Some pests identified in this assessment have been recorded in some regions of Australia, and due to interstate quarantine regulations are considered pests of regional concern. The acronym for the state or territory for which the regional pest status is considered, such as 'WA' (Western Australia) and 'NT' (Northern Territory), is used to identify these pests.

The pre-harvest, harvest and post-harvest production practices, as described in Chapter 3, are taken into consideration in estimating the likelihood of pest introduction with strawberries from Korea. Key aspects being considered include harvesting, transport, grading and packaging of strawberries. While the assessments of the unrestricted risk undertaken in this risk analysis do not impose any mandatory measures during pre-harvest, transport and packing, common commercial practices may impact on the survival of some pests. If these conditions are applied to all Korean strawberries bound for export, then those conditions can be considered as part of the assessment of the unrestricted risk.

Table 4.1 Quarantine pests for strawberries from Korea for which a full pest risk assessment is conducted

Pest	Common name
Bacteria	
<i>Xanthomonas fragariae</i>	angular leaf spot

Table 4.2 Quarantine pests for strawberries from Korea for which the URE outcome is adopted from previous assessments

Pest	Common name
Thrips (Thripidae)	
<i>Frankliniella intonsa</i> (EP)	Eurasian flower thrips
<i>Frankliniella occidentalis</i> (EP, NT)	western flower thrips

EP: Species has been assessed previously and import policy already exists.

NT: Pest of quarantine concern for the Northern Territory.

Table 4.3 Quarantine pests for strawberries from Korea for which some of the likelihood ratings and consequence estimates are adopted from previous assessments

Pest	Common name
Spider mites [Trombidiformes: Tetranychidae]	
<i>Tetranychus kanzawai</i> (EP, WA)	Kanzawa spider mite
Fungi	
<i>Monilia polystroma</i> (EP)	Asiatic brown rot
<i>Monilinia fructigena</i> (EP)	brown rot

EP: Species has been assessed previously and import policy already exists.

WA: Pest of quarantine concern for Western Australia.

Table 4.4 Quarantine pests for strawberries from Korea for which the likelihood ratings and consequence estimates have been determined in previous assessments

Pest	Common name
Fruit flies [Diptera: Drosophilidae]	
<i>Drosophila suzukii</i> (EP)	spotted wing drosophila

EP: Species has been assessed previously and import policy already exists.

Assessments for quarantine pests for which a full pest risk assessment is conducted

4.1 Angular leaf spot

Xanthomonas fragariae

Angular leaf spot is a disease of strawberries caused by a gram-negative bacterium *Xanthomonas fragariae* (Parkinson et al. 2007). *Xanthomonas fragariae* was first detected in Minnesota, USA in 1960 (Kennedy & King 1962a) and has since become an important pest of strawberries in the United States.

Natural hosts of this bacterium appear to be limited to strawberries. Experimental data indicate susceptibility to *X. fragariae* varies among different strawberry cultivars (Bestfleisch et al. 2015; Maas et al. 2000), with fully resistant genotypes not yet identified.

In Australia *X. fragariae* has been found in Gosford in 1975, Adelaide Hills in 1994 and Bundaberg in 2010. These outbreaks have since been eradicated and Australia is now considered to be free from *X. fragariae* (Australian Government Department of Agriculture 2012; EPPO 1996; Gillings, Fahy & Bradley 1998; McGechan & Fahy 1976; Young et al. 2011).

Xanthomonas fragariae may infect all vascular tissue including the crown, leaves, roots, petioles, stolons, daughter plants and calyx (Anco & Ellis 2011; Bestfleisch et al. 2015; Heidenreich & Turechek 2016; Louws, Harrison & Garrett 2014). The bacterium infects the leaves of wild and cultivated strawberry plants causing water-soaked lesions to form on the lower surface of the leaf (Gubler et al. 1999; Kwon et al. 2010; Peres 2014; Stöger et al. 2008). The lesions are initially small and irregular in shape, under high moisture conditions they may enlarge, becoming angular in shape and forming reddish-brown spots. These may develop into necrotic tissue and may exude bacteria in an ooze (Heidenreich & Turechek 2016; Hildebrand, Schroth & Wilhelm 1967; Peres 2014).

Infection of strawberry leaves occurs through the stomata. Under optimal conditions or once the infection has become systemic, the calyx may become infected with symptoms identical to those of leaves (Heidenreich & Turechek 2016; Peres 2014). Under favourable conditions the lesions on the calyx and flowers can secrete bacteria in the form of viscous droplets (Gubler et al. 1999; Peres 2014). In the crown, water-soaked lesions may be localised or confined to one section (Hildebrand, Schroth & Wilhelm 1967).

In addition to host specificity, many *Xanthomonas* species and pathovars show tissue specificity as well, invading either intercellular spaces of mesophyll tissue (mesophylic pathogens) and/or xylem elements of vascular tissue (vascular pathogens) (Ryan et al. 2011). Hildebrand, Schroth and Wilhelm (1967) reported that *X. fragariae* is a vascular pathogen, being found in both cambium and xylem tissue. The spread of *X. fragariae* occurs through infected propagative material, overhead irrigation, rain splash and windblown droplets (Hildebrand, Schroth & Wilhelm 1967). Seed transmission has not been demonstrated.

Outbreaks of this disease in California are associated with rainfall or overhead irrigation, with higher levels of infection in nurseries planted in spring (Hildebrand, Schroth & Wilhelm 1967).

The risk scenario of concern for *X. fragariae* is that symptomless infected strawberry fruit may be imported into Australia.

4.1.1 Likelihood of entry

The likelihood of entry is considered in two parts, the likelihood of importation and the likelihood of distribution, which consider pre-border and post-border issues, respectively.

Likelihood of importation

The likelihood that *Xanthomonas fragariae* will arrive in Australia with the importation of strawberries from Korea is: **Moderate**.

The following information provides supporting evidence for this assessment.

- *Fragaria* spp. and *Fragaria × ananassa* are highly susceptible to angular leaf spot caused by *Xanthomonas fragariae* (Bestfleisch et al. 2015; Maas et al. 2000; Stöger et al. 2008).
- *Xanthomonas fragariae* has been reported present in Sugok-myon, Jinju city, Okjong-myon, Hadong-gun in Gyeongsangnam-do province (Kwon et al. 2010). Gyeongsangnam-do province is one of the major strawberry producing areas accounting for 34 per cent of total strawberry production (QIA 2015b).
- Angular leaf spot has been reported on strawberries in Korea in both open field farms and greenhouses (Kwon et al. 2010).
- Korea currently tests for the presence of *X. fragariae* in imported runner daughter plants (QIA 2015b). However no testing for this pathogen takes place during production process for certified plantlets. Plantlets with obvious symptoms of infection are likely to be removed during the multiplication process. Some infected plantlets may exhibit no or mild symptoms and may be used during the multiplication process.
- Infected plants can remain asymptomatic until optimum conditions for the disease to develop are present (Louws, Harrison & Garrett 2014; Mahuku & Goodwin 1997; NPPO the Netherlands 2013; Roberts et al. 1996; Wang & Turechek 2016).
- Transmission of this bacterium can occur over a short distance via rain/water splash (Hildebrand, Schroth & Wilhelm 1967; Roberts, Jones & Chandler 1997). Greenhouse production is not exposed to rainfall and overhead irrigation is not used, which would limit the spread of the bacterium, if present.
- *Xanthomonas fragariae* can infect strawberry leaves and crowns through the stomata and fresh wounds (Anco & Ellis 2011; George & Fox 2014; Schilder 2016; University of Minnesota 2016). No information has been found on how other tissues can be infected.
- Strawberries with obvious symptoms of infection in the calyx are likely to be removed during harvesting and packing procedures and would not be packed for export. Strawberries that are asymptomatic or with only mild symptoms on the calyx could escape detection during packing procedures and be exported.
- Strawberries are usually stored and transported at low temperatures to prolong shelf life. *Xanthomonas fragariae* is slow growing and can survive cold storage in host tissue up to one year (Hildebrand, Schroth & Wilhelm 1967; Louws, Harrison & Garrett 2014). Some infected fruit may exhibit no or mild symptoms at the time they arrive in Australia.

Xanthomonas fragariae has been reported on strawberries in both open field farms and greenhouses in Korea. Strawberry plants used in fruit production are the progeny of registered plantlets which have been through rigorous selection process. This would reduce the likelihood of infected plants being used in fruit production. Conditions in greenhouse production limits the ability to spread of the bacterium, if present. Fruit (calyx) infection only occurs under optimum conditions or when the infection is systemic. Infected calyx may be symptomless and are likely to pass through the packing procedures undetected. The bacterium is likely to survive cold

temperatures during storage and transportation. Some infected strawberry fruit may still exhibit no or mild symptoms on arrival in Australia. This information supports a likelihood estimate for importation of 'moderate'.

Likelihood of distribution

The likelihood that *Xanthomonas fragariae* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of strawberry fruit from Korea and subsequently transfer to a susceptible part of a host is: **Low**.

The following information provides supporting evidence for this assessment.

- Imported strawberries are intended for human consumption. Distribution would be for retail sale and likely to be Australia wide.
- As strawberries will be packaged in punnets, packed strawberries may not be processed or handled again until they arrive at retailers. Therefore, the bacterium, if present in packed strawberries, is unlikely to be detected during transportation and distribution to retailers.
- Strawberries with obvious symptoms of infection would not be marketable and would not be sold. Strawberries without symptoms, or with only minor symptoms, could be marketable and sold.
- Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips and would therefore pose little risk of exposure to a suitable host.
- Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost. There is some potential for consumer waste being discarded near host plants (strawberry plants), including commercially grown, household or wild host plants. If present in fruit waste, the bacterium would then need to be transferred to the host plants.
- *Xanthomonas fragariae* cannot survive in soil without a host (Anco & Ellis 2011). However, the bacterium can remain viable from one season to the next on tissue and dried leaves under the soil for up to a year (Anco & Ellis 2011; Heidenreich & Turechek 2016; Kennedy & King 1962b; Naqvi 2004; Peres 2014).
- Generally survival of a pathogen in fruit waste is expected to be short due to dehydration and competition with other organisms. However, based on the above studies regarding the survival of this bacteria in soil on tissue and dried leaves, it is possible that the bacterium could survive in fruit waste for a longer period of time increasing the chances of the bacterium coming into contact with the host plants.
- To date, strawberries are the only confirmed natural hosts of *X. fragariae* (Kennedy 1965; NPPO the Netherlands 2013). In Australia strawberries are grown in all states commercially and are also grown as a garden plant in household (ABS 2016). Strawberries are infrequently encountered as a weed in Australia (CHAH 2016; Groves 2002). There are reports of naturalised *Fragaria vesca* in localised areas in New South Wales and Queensland and *Fragaria × ananassa* in localised areas in South Australia (CHAH 2016; Groves 2002).
- Kennedy (1965) reported that under experimental conditions species in the genus *Potentilla* can become infected by *X. fragariae*. Species in the genus *Potentilla* can be found distributed throughout Australia (CHAH 2016). However, there have been no reports of infection of *Potentilla* under natural conditions in the field.
- On host plants the bacterium can be transmitted over short distances via water splash approximately three metres, possibly further under extreme weather conditions (Roberts, Jones & Chandler 1997). Any bacteria splashed onto a non-host or soil is expected to not survive for long.

- To date, there have been no vectors identified for this bacterium.
- Transmission of *X. fragariae* through seeds is suspected to be possible (Mark Herrington [Queensland Department of Agriculture and Fisheries] 2016 pers. comm., 20 May). However, there is no evidence to confirm seed transmission of this bacterium yet.
- Strawberry seeds (achenes) may germinate producing plants. However, most seeds are dormant and will not germinate without scarification (Galvão et al. 2014). Scarification may include heat treatment, cutting the seed or the use of chemicals (El Hamdouni 2001; Guttridge & Bright 1978; Ito et al. 2011; Miller et al. 1992; Nakamura 1972; Thompson 1968; Wilson, Goodall & Reeves 1973). These treatments are unlikely to be met outside of commercial situations. Due to this reason, germination of strawberry seed from fruit waste is considered unlikely.

Imported strawberries are intended for human consumption and would likely be distributed Australia wide. Strawberries will be packaged in punnets and may not be processed or handled again until they arrive at retailers. Small quantities of fruit waste could be discarded in urban, rural and natural localities. *Xanthomonas fragariae* can potentially survive for a long period of time on infested fruit waste. Natural hosts of *X. fragariae* are limited to plants of the genus *Fragaria*. This bacterium is transmitted via water splash which limits its potential for dispersal to short distances and no vectors have been identified. Although the possibility of this bacterium being transmitted through seed is suspected, seed transmission is not confirmed. Strawberry seeds are unlikely to germinate without treatment. This information supports a likelihood estimate for distribution of 'low'.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *Xanthomonas fragariae* will enter Australia as a result of trade in strawberry fruit from Korea and be distributed in a viable state to a susceptible host is: **Low**.

4.1.2 Likelihood of establishment

The likelihood that *Xanthomonas fragariae* will establish within Australia based on a comparison of factors in the source and destination areas that affect pest survival and reproduction is: **High**.

The following information provides supporting evidence for this assessment.

- Strawberries, the natural host for *X. fragariae*, are widely grown commercially and domestically across Australia. Plants in the genus *Fragaria* are highly susceptible to *X. fragariae* (Bestfleisch et al. 2015; Maas et al. 2000).
- *Xanthomonas fragariae* cannot survive in soil without a host (Anco & Ellis 2011). However, it can remain viable from one season to the next on tissue and dried leaves under the soil for up to a year (Anco & Ellis 2011; Kennedy & King 1962b; Naqvi 2004; Peres 2014). *Xanthomonas fragariae* gathered from leaf material stored for 21 years has been found to be viable (Kong 2010).
- Preferred environmental conditions for bacterial development are warm days around 20 °C and cold nights at 2 °C (Kennedy-Fisher 1997; Kennedy & King 1962b; Naqvi 2004; Peres 2014). High humidity levels affect disease development (Hildebrand et al. 2005; Kennedy & King 1962b) with rain and overhead irrigation increasing the chances of disease outbreak (Epstein 1966; Hildebrand, Schroth & Wilhelm 1967). These climate conditions can be found in some strawberry production regions of Australia. In some areas overhead irrigation may also be used to protect strawberries from frost damage, increasing the likelihood of establishment in those areas (DAFWA 2015; Naqvi 2004; Nicholls et al. 2008).

- Korean strawberries are expected to be exported between January and March, during Australia's summer. Average temperatures in Australia during this period range from 12 °C to 36 °C (Bureau of Meteorology 2016). High temperatures above 28 °C are unfavourable for the expression of angular leaf spot and may reduce the potential for the bacterium to infect the host plants (Kennedy & King 1962a). However, Roberts et al. (1996) reported that bacteria are likely to survive higher temperatures, remaining asymptomatic in the plant material until optimum conditions are available.
- Strawberries are infrequently encountered outside managed cultivation in Australia (CHAH 2016; Groves 2002). There are reports of naturalised *Fragaria vesca* in localised areas in New South Wales and Queensland and *Fragaria* × *ananassa* in localised areas in South Australia (CHAH 2016; Groves 2002). These plants may become infected becoming a source of inoculum for the bacterium. The localised and infrequent distribution of these plants will limit them as a source of inoculum for infection.
- Previous outbreaks of *X. fragariae* occurred in Gosford in 1975, in Adelaide Hills in 1994 and in Bundaberg in 2010 (Gillings, Fahy & Bradley 1998; McGechan & Fahy 1976; Young et al. 2011) indicating that suitable environmental conditions for *X. fragariae* exist in Australia.
- Currently *X. fragariae* is known to be established in multiple countries over a variety of climatic zones including Argentina, Brazil, Canada, Ethiopia, France, Germany, Italy, Korea, Paraguay, Taiwan, United States, Uruguay and Venezuela (CABI & EPPO 1997b; NPPO the Netherlands 2013). Environments with climate conditions similar to these regions exist in various parts of Australia, suggesting *X. fragariae* has the potential to establish in Australia.
- Transmission of *X. fragariae* through seeds is suspected to be possible (Mark Herrington [Queensland Department of Agriculture and Fisheries] 2016 pers. comm., 20 May). However, there is no evidence to confirm seed transmission of this bacterium yet.

Plants in the genus *Fragaria* are highly susceptible to *X. fragariae*. *Xanthomonas fragariae* is able to survive long periods of time in adverse conditions. Environmental conditions suitable for the development of angular leaf spot can be found in some strawberry growing areas of Australia. Outbreaks of *X. fragariae* previously occurred in Australia. This information supports a likelihood estimate for establishment of 'high'.

4.1.3 Likelihood of spread

The likelihood that *Xanthomonas fragariae* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest is: **Moderate**.

The following information provides supporting evidence for this assessment.

- *Xanthomonas fragariae* can be transmitted via infected tools, machinery and humans who come in contact with the bacterium (Naqvi 2004).
- *Xanthomonas fragariae* can be dispersed over short distances, approximately three metres, via water splash, including rain and water which has touched the surface of infected tissues including overhead sprinkler irrigation. Dispersal distance could be further under extreme weather conditions (Roberts, Jones & Chandler 1997).
- *Xanthomonas fragariae* can be transmitted through infected plants introduced to a field (Peres 2014). Infected nursery stock can be symptomless retaining the inoculum to spread to other host plants (Mahuku & Goodwin 1997).
- Long distance dispersal of *X. fragariae* is more likely to be through the movement of infected strawberry planting material (runners). However, strawberry planting material certified as being free of pests and pathogens is available from the Queensland Strawberry Runner

Accreditation Scheme and the Victorian Certified Runner Scheme (DAFWA 2016; Strawberries Australia 2016; Strawberries Australia Inc 2012). The Victorian Certified Runner Scheme produces 75 per cent of Australian strawberry runners used in national fruit production (Victorian Strawberry Industry Certification Authority 2010), making this pathway for spread less likely.

- Natural hosts of *X. fragariae* are limited to plants in the genus *Fragariae*. Strawberries are grown commercially and domestically in all states of Australia and can be grown domestically in the ACT and NT (ABS 2016). *Fragaria vesca* and *Fragaria × ananassa* can be infrequently encountered in unmanaged environment of Australia (CHAH 2016; Groves 2002).
- *Xanthomonas fragariae* has been isolated from *Potentilla* under experimental conditions (Kennedy 1965). Species in *Potentilla* can be found distributed throughout Australia (CHAH 2016). However, there have been no reports of infection of these hosts under natural conditions in the field. Transmission of *X. fragariae* through seeds is suspected to be possible (Mark Herrington [Queensland Department of Agriculture and Fisheries] 2016 pers. comm., 20 May). However, there is no evidence to confirm seed transmission of this bacterium yet.
- To date, there have been no vectors identified for this bacterium.

Xanthomonas fragariae can be transmitted via infected tools, machinery and humans who come in contact with the bacterium. *Xanthomonas fragariae* can only be transmitted over short distances via water splash. Long distance dispersal of this bacterium could occur through the movement of infected strawberry planting material. However, strawberry planting material is certified as being free of pests and pathogens from Queensland Strawberry Runner Accreditation Scheme and the Victorian Certified Runner Scheme, making this mode of spread less likely. This information supports a likelihood estimate for spread of 'moderate'.

4.1.4 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The overall likelihood that *Xanthomonas fragariae* will enter Australia as a result of trade in strawberry fruit from Korea, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **Low**.

4.1.5 Consequences

The potential consequences of the establishment of *Xanthomonas fragariae* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more criteria are 'E', the overall consequences are estimated to be **Moderate**.

Criterion	Estimate and rationale
Direct	
Plant life or health	<p>E—Significant at the regional level</p> <p>Reports on yield loss caused by <i>X. fragariae</i> have been inconsistent.</p> <p>In the United States, Roberts (1997) recorded a yield loss of 8 per cent in Florida in two consecutive seasons independent of disease severity, while Epstein (1966) reported a loss of between 75 and 80 per cent in Wisconsin.</p> <p>The magnitude of impact of angular leaf spot could depend on climatic and cultivation conditions (NPPO the Netherlands 2013).</p> <p>The natural host range of <i>X. fragariae</i> appears to be limited to plants in the genus <i>Fragariae</i> (strawberries). Strawberries are grown commercially in all of Australia except the NT and ACT (ABS 2016). In 2011, 72,500 tonnes of strawberries were produced in Australia worth about \$400 million.</p> <p>The extent of damage this bacterium may cause, if established, in Australia could be significant. Optimum conditions for disease development are temperatures around 20 °C during the day, night time temperatures of 2 °C, high humidity levels with rain and overhead irrigation (Epstein 1966; Hildebrand, Schroth & Wilhelm 1967; Hildebrand et al. 2005; Kennedy-Fisher 1997; Kennedy & King 1962b; Naqvi 2004; Peres 2014). These conditions can be found in some strawberry growing regions of Australia.</p>
Other aspects of the environment	<p>A—Indiscernible at the local level</p> <p>There are currently no known direct consequences of this bacterium on other aspects of the natural environment.</p>
Indirect	
Eradication, control	<p>E—Significant at the regional level</p> <p>Eradication of previous outbreaks in Australia has required the destruction of all plant material in the affected areas. These areas remained host-free for a period of two years with all equipment and machinery requiring decontamination. Eradications have also required the use of disinfectants, which can cause safety risks and environmental issues (McGechan & Fahy 1976; Young et al. 2011).</p> <p>State governments have incurred significant costs in eradication of previous localised outbreaks. If <i>X. fragariae</i> spreads to the strawberry runner industry, multiple states and industry stakeholders would be affected incurring substantial costs associated with regulatory enforcement and implementation of any contingency plan for control, eradication, surveillance and monitoring (Heidenreich & Turechek 2016; Turechek & Peres 2009; Vermunt & Van Beuingen 2008). However, strawberry runner scheme are highly regulated and it is less likely that the bacterium would affect this part of the strawberry industry.</p>
Domestic trade	<p>D—Significant at the district level</p> <p>The presence of <i>X. fragariae</i> in commercial production areas is likely to result in interstate trade restrictions on strawberries and strawberry runners, potential loss of markets and significant industry adjustment at the district level.</p>
International trade	E—Significant at the regional level

	<p>At present <i>X. fragariae</i> can be found in parts of Africa, Asia, Europe, North America and South America (NPPO the Netherlands 2013).</p> <p>The presence of <i>X. fragariae</i> is likely to have a negative impact on international trade restrictions on strawberry seed and strawberry runners.</p> <p>Multiple trading partners including the European Union, United States and China require measures for strawberry planting material and seeds with material being required to originate from a country or area free of this bacterium (Department of Agriculture and Water Resources 2016b; NPPO the Netherlands 2013).</p> <p>Exports of strawberries have increased in recent years however, currently the majority of strawberries produced in Australia are sold domestically. The presence of the pathogen in commercial production areas of strawberry fruit in Australia could potentially limit access to some overseas markets that are free of this bacterium.</p>
Environmental and non-commercial	<p>B—Minor significance at the local level</p> <p>Australia does not have any native species of strawberry. However, <i>Fragaria</i> spp. have naturalised to a limited extent in Australia. <i>Fragaria vesca</i> in New South Wales and Queensland and <i>Fragaria × ananassa</i> in South Australia (CHAH 2016; Groves 2002). There are no reports of <i>X. fragariae</i> infecting plant species other than strawberry under natural conditions. Species in <i>Potentilla</i> can be found distributed throughout Australia (CHAH 2016). Kennedy (Kennedy 1965) reported that under experimental conditions species in <i>Potentilla</i> can become infected by <i>X. fragariae</i>. However, there have been no reports of infection of these hosts under natural conditions in the field. Therefore impact on other plant species in Australia is considered to be minimal.</p> <p>Any additional usage of pesticide sprays may affect the environment, with minor impact at local level.</p>

4.1.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for <i>Xanthomonas fragariae</i>	
Overall likelihood of entry, establishment and spread	Low
Consequences	Moderate
Unrestricted risk	Low

As indicated, the unrestricted risk estimate for *Xanthomonas fragariae* has been assessed as 'low', which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for this pest.

Assessments for quarantine pests for which the URE outcome is adopted from previous assessments

4.2 Thrips

***Frankliniella intonsa* (EP) and *Frankliniella occidentalis* (EP, NT)**

Frankliniella intonsa (Eurasian flower thrips) and *F. occidentalis* (western flower thrips) have been grouped together because of their related biology and taxonomy, and they are predicted to pose a similar risk and to require similar mitigation measures.

Frankliniella occidentalis is not present in the Northern Territory and is a pest of quarantine concern for that territory. *Frankliniella intonsa* is not present in any part of Australia and is therefore a pest of quarantine concern for the whole of Australia.

Both thrips species were assessed previously in a number of existing import policies, for example, in the import policy for capsicums from Korea (Biosecurity Australia 2009a), unshu mandarins from Japan (Biosecurity Australia 2009b), and stone fruit from the United States (Biosecurity Australia 2010b). *Frankliniella occidentalis* was also included in the import policy for table grapes from China (Biosecurity Australia 2011a), Japan (Australian Department of Agriculture 2014) and Korea (Biosecurity Australia 2011b), as well as several other existing policies. In these policies, the unrestricted risk estimates for thrips were all assessed as exceeding the ALOP for Australia. Therefore, specific risk management measures are required for thrips.

The department considered factors affecting the likelihood of importation for thrips for strawberries from Korea and those previously assessed. The department considers that the likelihood of importation for thrips for strawberries from Korea would be comparable to that in the previous assessments.

Thrips have a wide host range and host material is likely to be available all year round in Australia. The likelihood of distribution for these pests for strawberries from Korea would be comparable to that for commodities assessed previously.

The likelihood of establishment and spread of *F. intonsa* in Australia and *F. occidentalis* in the Northern Territory for strawberries from Korea will be comparable to previous assessments. These likelihoods relate specifically to events that occur in Australia and are principally independent of the importation pathway. The consequences of *F. intonsa* in Australia and *F. occidentalis* in the Northern Territory are principally independent of the importation pathway.

In addition, the department has also reviewed the latest literature and no new information is available that would significantly change the risk ratings for importation, distribution, establishment, spread and consequences as set out for thrips in existing policies.

4.2.1 Unrestricted risk estimate

The unrestricted risk estimate for thrips for strawberries from Korea is comparable to the estimates in previous assessments, and does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for these pests.

Assessments for quarantine pests for which some of the likelihood and/or consequence ratings are adopted from previous assessments

4.3 Kanzawa spider mite

Tetranychus kanzawai (EP, WA)

Tetranychus kanzawai is not present in the state of Western Australia and is a pest of quarantine concern for that state.

Tetranychus kanzawai is a spider mite native to East Asia. It is referred to as a 'spider mite' due to its habit of spinning silken webs on plants, within which they seek shelter from predators and unfavourable environmental conditions (Yano 2012; Oku et al 2009). Adults are small in size; females grow to between 0.3 and 0.5 millimetres long (Zhang 2008) and males are typically smaller.

Tetranychus kanzawai is highly polyphagous as a species, feeding on plants such as pear, tea, hydrangea, as well as strawberry, but exhibits strong intraspecific differences, and different populations have been shown to have different food preferences, responses in temperature, even reproductive incompatibility (Gomi & Gotoh 1996; Hinomoto & Takafuji 2011; Takafuji, Santoso & Hinomoto 2001). Whilst some populations were shown not to be capable of completing their lifecycle on certain plants, all known populations are capable of completing their lifecycle on strawberry plants (Gomi & Gotoh 1996).

Tetranychus kanzawai has in total five stages of life—egg, larva, protonymph, deutonymph, and adult (CABI 2016). Their short lifecycle means that they go through many generations in a year (Gotoh & Gomi 2000). All spider mites feed by piercing plant cells and consuming their contents (Zhang 2008). Leaves damaged by *Tetranychus* develop yellowish/brownish spots due to the removal of moisture by feeding and large numbers may result in stunted growth of plants, reduced fruit quality, and eventually plant death (Alford 2007; CABI 2016; Zhang 2008). Strawberry plants have been recorded as a viable host of *T. kanzawai* (Gomi & Gotoh 1996; Zhang et al. 1996b).

Tetranychus kanzawai can survive in a wide range of temperatures. In a study of its growth performance at different temperatures (Ullah et al. 2011), it was found to be able to reach maturity at constant temperatures of 15 °C up to a temperature of 37.5 °C. The fastest development time from newly laid egg to adult was found at 35 °C, at an average of 5.3 days for females and 5.1 days for males with a period of less than a day before adults started laying eggs (Ullah et al. 2011). The slowest development time was found at 15 °C, at 24.5 days for females and 24.4 days for males (Ullah et al. 2011). At a constant temperature of 40 °C, some *T. kanzawai* eggs hatched, but none of the larvae reached adulthood (Ullah et al. 2011). Yang et al (1991) found in their study that 22 per cent of *T. kanzawai* adults could survive temperatures as low as -5 °C for ten days, but on the other hand, Ullah et al (2011) reported that development stopped and the lowest temperature at which a population can reproduce was likely closer to 10 °C. The differences may be dependent on the population it came from (Takafuji, Santoso & Hinomoto 2001).

The risk scenario of concern is that *T. kanzawai* adults and larvae are present on harvested strawberry fruit and brought to Australia.

Tetranychus kanzawai was included in the existing import policy for table grapes from Japan (Australian Department of Agriculture 2014), Korea (Biosecurity Australia 2011b), and China (Biosecurity Australia 2011a). The assessment of *T. kanzawai* presented here builds on these existing policies.

Tetranychus kanzawai has a wide host range and host material is likely to be available all year round in Australia. In addition, after importation strawberries will be distributed throughout Australia for retail sale in a similar way to table grapes assessed previously. Therefore, the likelihood of distribution for this pest for strawberries from Korea would be comparable to that assessed previously.

The likelihood of establishment and spread of *T. kanzawai* in Western Australia for strawberries from Korea will be comparable to previous assessments. These likelihoods relate specifically to events that occur in Australia and are principally independent of the importation pathway. The consequences of *T. kanzawai* in Western Australia are also principally independent of the importation pathway.

In addition, the department has also reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for *T. kanzawai* in the existing policies.

However, differences in climatic conditions, the commodity, pest prevalence and commercial production practices between previous exporting areas and Korea make it necessary to reassess the likelihood of importation of *T. kanzawai* into WA with strawberries from Korea.

4.3.1 Likelihood of entry

The likelihood of entry is considered in two parts, the likelihood of importation and the likelihood of distribution, which consider pre-border and post-border issues, respectively.

Likelihood of importation

The likelihood that *Tetranychus kanzawai* will arrive in Australia with the importation of strawberries from Korea is: **Moderate**.

The following information provides supporting evidence for this assessment.

- *Tetranychus kanzawai* is known to be a pest of strawberries in Korea (QIA 2015b) and is known to be capable of completing its lifecycle on strawberry plants (Gomi & Gotoh 1996; Zhang et al. 1996a).
- Whilst *Tetranychus* mites feed mainly on leaves, they may be found on fruit during high infestation levels (NAPPO 2014).
- High infestation levels of *T. kanzawai* leads to noticeable direct damage to the plant as well as silk webbing on the areas infested (Zhang 2008). There is also comparatively small space for *T. kanzawai* to hide on strawberry fruit when compared to grape bunches, and strawberries are picked and packed individually. Therefore, more heavily infested fruit is likely to be detected and removed during standard commercial quality processes.
- *Tetranychus* mites are capable of entering diapause when under stress, and can survive for long periods of time in low temperatures and even develop a tolerance for low oxygen levels (Suzuki et al 2015) which may be experienced during air freight. Unpublished Department of Agriculture and Water Resources data indicate that *Tetranychus* mites have been intercepted in strawberries from the United States and were found under the calyx.

- *Tetranychus kanzawai* has been found to survive temperatures of -5 °C for ten days, suggesting it can survive cold storage and transport (Yang, Cao & Chen 1991).

Tetranychus kanzawai is a pest of strawberries in Korea and is capable of completing its lifecycle on strawberry plants. They may not be detected during harvest or packing house procedures due to their small size. They can survive low temperatures during storage and transportation. However, during high infestation levels, significant damage occurs on fruit which would lead to their removal from the export pathway. In the case of lower infestation levels, *T. kanzawai* is highly unlikely to be present on the fruit at all. This information supports a likelihood estimate for importation into Western Australia of 'moderate'.

Likelihood of distribution

The likelihood that *Tetranychus kanzawai* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of strawberry fruit from Korea and subsequently transfer to a susceptible part of a host assessed here would be similar for table grapes from China (Biosecurity Australia 2011a) and table grapes from Korea (Biosecurity Australia 2011b), that is: **Moderate**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *Tetranychus kanzawai* will enter Australia as a result of trade in strawberries from Korea and be distributed in a viable state to a susceptible host is: **Low**.

4.3.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for *Tetranychus kanzawai* is being based on the assessment for table grapes from China (Biosecurity Australia 2011a), and table grapes from Korea (Biosecurity Australia 2011b). The ratings from the previous assessments are:

Likelihood of establishment	High
Likelihood of spread	Moderate

4.3.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The overall likelihood that *Tetranychus kanzawai* will enter Australia as a result of trade in strawberries from Korea, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **Low**.

4.3.4 Consequences

As indicated, consequences of *T. kanzawai* in Western Australia assessed here are based on the previous assessment for *T. kanzawai* for table grapes from China (Biosecurity Australia 2011a), which was adopted for table grapes from Korea (Biosecurity Australia 2011b) and Japan (Australian Department of Agriculture 2014), that is **Moderate**.

4.3.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for <i>Tetranychus kanzawai</i>	
Overall likelihood of entry, establishment and spread	Low
Consequences	Moderate
Unrestricted risk	Low

As indicated, the unrestricted risk estimate for *Tetranychus kanzawai* has been assessed as 'low', which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for this pest.

4.4 Brown rot

***Monilinia fructigena* (EP) and *Monilia polystroma* (EP)**

Brown rot is a fungal disease of stone and pome fruit caused by a number of closely related species of the genus *Monilinia*. The anamorph of the fungus is the genus *Monilia*. The genus belongs to family Sclerotiniaceae and it can cause severe losses and damage to stonefruit (Zhu, Chen & Guo 2011). However it has also been reported on other hosts including grapes and strawberries (Byrde & Willets 1977; CABI 2016; Cline & Farr 2006). Symptoms caused by brown rot fungi in general include blossom and leaf blight, cankers on woody tissues and rotting of fruit (Byrde & Willets 1977). However, brown rot primarily infects fruit, rarely blossoms and twigs (Farr & Rossman 2016).

The biology and taxonomy of *Monilinia fructigena* and *Monilia polystroma* are considered sufficiently similar to justify combining them into a single assessment. The assessment of the pathogens has been largely based on the scientific information on *Monilinia fructigena* as it is predicted to pose a similar risk and require similar mitigation measures. Unless explicitly stated, the information presented is considered as applicable to both species. In this assessment, the common name 'brown rot' is used to refer to both species unless otherwise specified.

The risk scenario of concern for *Monilinia fructigena* and *Monilia polystroma* is that symptomless infected fruit might enter Australia and result in the establishment of these fungi in Australia.

Monilinia fructigena was assessed in the existing import policy for apples (Biosecurity Australia 2010a), and table grapes from China (Biosecurity Australia 2011a). Both *Monilinia fructigena* and *Monilia polystroma* were included in the existing policy for nectarines from China (Australian Government Department of Agriculture and Water Resources 2016) and table grapes from Japan (Australian Department of Agriculture 2014). The assessment of *Monilinia fructigena* and *Monilia polystroma* presented here builds on these existing policies.

Differences in commodity climate conditions, pest prevalence and horticultural practices between previous export areas and Korea make it necessary to reassess the likelihood of importation of brown rot into Australia with strawberries from Korea.

Brown rot fungi has multiple hosts. After importation, strawberries will be distributed throughout Australia for retail sale in a similar way to table grapes assessed previously. The likelihood of distribution for these fungi for strawberries from Korea would be comparable to that assessed previously.

The likelihood of establishment and spread of brown rot fungi in Australia will be comparable to previous assessments. These likelihoods relate specifically to events that occur in Australia and are principally independent of the importation pathway. The consequences of brown rot in Australia are also principally independent of the importation pathway.

In addition, the Australian Government Department of Agriculture and Water Resources has reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for brown rot fungi in the existing policies.

Monilinia fructigena is recorded in Korea (CABI 2016; Kim & Koo 2009). In Japan, *Monilia polystroma* was identified from pear and apple isolates previously identified as

Monilinia fructigena (Van Leeuwen et al. 2002). It has been suggested isolates of *Monilinia fructigena* should be re-examined to determine whether they may be *Monilia polystroma* (Chalkley 2010; Van Leeuwen et al. 2002). For this reason, it is assumed that *Monilia polystroma* is likely to be present in Korea.

4.4.1 Likelihood of entry

The likelihood of entry is considered in two parts, the likelihood of importation and the likelihood of distribution, which consider pre-border and post-border issues, respectively.

Likelihood of importation

The likelihood that *Monilinia fructigena* and *Monilia polystroma* will arrive in Australia with the importation of strawberry fruit from Korea is: **Very low**.

The following information provides supporting evidence for this assessment.

- *Fragaria* spp. are not reported as main hosts but they are susceptible to brown rot caused by *Monilinia fructigena* and *Monilia polystroma* (CABI 2016; Kim & Koo 2009). Information on their biology on strawberry fruit has not been found.
- Brown rot is a pathogen favoured by moist conditions (rain, fog and other factors that increase humidity), especially at the beginning of the host's growth periods. High light levels with warm temperatures and wet and humid conditions favour spore germination and infections (Batra 1991; Byrde & Willets 1977; CABI 2016; Jones 1990). Korea has mild springs with warm and humid summers (KMA 2011). The green house climate is controlled to replicate summer/spring conditions with day time temperatures between 20 and 25 °C. This climate is conducive to the development of brown rot and suggests that the disease, if present, is likely to be detected.
- However, no records have been found of *Monilinia fructigena* or *Monilia polystroma* on strawberries in Korea.
- Brown rot fungi have the ability to cause latent infection in fruit (Gell et al. 2009). The infected fruit may not produce symptoms of disease until the fruit begins to ripen during storage and transport, on the market shelf, or as the fruit senesces (Byrde & Willets 1977).
- On stone fruit healthy fruit can be contaminated with conidia in the field or during processes in the packing house (Ma 2006). Wounded fruit may also be contaminated with conidia during packing house processes via fruit to fruit contact (Xu & Robinson 2000) allowing brown rot to develop during the postharvest period. It is assumed this may be possible for strawberries, increasing the chance of strawberries with no or mild symptoms to be packed for export if they are infected during the packing process.
- On stone fruit, brown rot fungi overwinter mainly in or on infected mummified fruit, either attached to the tree or on the ground (Byrde & Willets 1977). Mycelia can survive long periods of adverse environmental conditions within mummified fruits, twigs, cankers and other infected tissues (Byrde & Willets 1977). This suggests that in infected fruit fungi may survive cold storage and transportation processes.

Brown rot fungi have the ability to cause latent infection in fruit, with symptomless infected fruit likely to pass through packing house processes undetected. Brown rot mycelia in infected fruit are likely to survive cold storage and transportation. However, strawberry is not a major host of brown rot fungi and there have been no reports of brown rot fungi affecting strawberries in Korea. This information supports a likelihood estimate for importation of 'very low'.

Likelihood of distribution

The likelihood that *Monilinia fructigena* and *Monilia polystroma* assessed here would be similar for *Monilinia fructigena* for apples (Biosecurity Australia 2010a) and table grapes (Biosecurity Australia 2011a) from China and table grapes (Biosecurity Australia 2011b) from Korea, that is: **High**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *Monilinia fructigena* and *Monilia polystroma* will enter Australia as a result of trade in strawberry fruit from Korea and be distributed in a viable state to a susceptible host is: **Very low**.

4.4.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for brown rot is being based on the assessment for apples from China (Biosecurity Australia 2010a), which was adopted for table grapes from China (Biosecurity Australia 2011a), Korea (Biosecurity Australia 2011b) and Japan (Department of Agriculture 2014). The ratings from the previous assessment are:

Likelihood of establishment **High**

Likelihood of spread **High**

4.4.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The overall likelihood that *Monilinia fructigena* and *Monilia polystroma* will enter Australia as a result of trade in strawberry fruit from Korea, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **Very low**.

4.4.4 Consequences

The potential consequences of the establishment of *Monilinia fructigena* in Australia has been estimated previously for apples from China (Biosecurity Australia 2010a). *Monilinia fructigena* and *Monilia polystroma* are considered to have a similar impact. The overall consequences have been estimated to be: **Moderate**.

4.4.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Monilinia fructigena* and *Monilia polystroma*

Overall likelihood of entry, establishment and spread	Very low
Consequences	Moderate
Unrestricted risk	Very low

As indicated, the unrestricted risk estimate for *Monilinia fructigena* and *Monilia polystroma* has been assessed as 'very low', which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for *Monilinia fructigena* and *Monilia polystroma*.

Assessments for quarantine pests for which the likelihood and consequence ratings have been determined in a previous assessment

4.5 Spotted wing drosophila

Drosophila suzukii (EP)

The quarantine risks posed by *Drosophila suzukii* from all countries and for all commodities, including strawberries, were previously assessed in the final pest risk analysis (PRA) report for *D. suzukii* (Department of Agriculture 2013). Therefore, there is no need to reassess this pest here. A summary of pest information and a summary of the previous risk assessment for strawberries from the final PRA report for *D. suzukii* is provided here.

Drosophila suzukii is native to temperate parts of Asia (Rota-Stabelli, Blaxter & Anfora 2013) and is widespread in Korea (Asplen et al. 2015; Lee 1964). It was also recently introduced into Europe where its distribution has spread dramatically in recent years (Calabria et al. 2012; Cini, Ioriatti & Anfora 2012), as well as North America (Asplen et al. 2015).

Drosophila suzukii preferentially oviposit on ripening fruit but will also oviposit on unripe and overripe fruit (Brewer et al. 2012; CABI 2016; Kanzawa 1939; Lee et al. 2011a). Larval feeding causes collapse of the fruit around the area of oviposition and high attack rates can lead to collapse of the entire fruit (Department of Agriculture 2013). Larvae feeding on very acidic fruit fail to complete development (Kanzawa 1935). In its native and introduced range, *D. suzukii* has been recorded to cause commercial damage to a range of fruits including cherries, blueberries and red bayberries, apricots, plums, strawberries and various caneberries (Lee et al. 2011a).

Monitoring programs in the northwest of the United States show trap catches in strawberry fields are high and strawberries are a preferred host for *D. suzukii* (OSU 2010a, b; Peerbolt 2010). In the eastern United States, high larval infestations in strawberries in North Carolina have been reported (Burrack 2010). Damage to commercial strawberries has also been recorded in Europe (EPPO 2010), with 60–100 per cent damage in infested areas (Grassi, Giongo & Palmieri 2011; Grassi & Pallaoro 2012; Süss & Costanzi 2010). Early in the season, when *D. suzukii* populations are lower and insecticide application more frequent, infestation levels range from 2–10 per cent (Grassi, Giongo & Palmieri 2011; Grassi & Pallaoro 2012).

The risk scenario of concern for *Drosophila suzukii* is the presence of the larvae and eggs in strawberries.

4.5.1 Overall likelihood of entry, establishment and spread

Based on the final PRA report for *D. suzukii* (Department of Agriculture 2013), the overall likelihood that *D. suzukii* will enter Australia as a result of trade in strawberries from Korea, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **High**.

4.5.2 Consequences

Based on the final PRA report for *D. suzukii* (Department of Agriculture 2013), the potential consequences of the establishment of *D. suzukii* in Australia are: **High**.

4.5.3 Unrestricted risk estimate

Based on the final PRA report for *D. suzukii* (Department of Agriculture 2013), the unrestricted risk estimate for *D. suzukii* has been assessed as 'high', which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for this pest.

4.6 Pest risk assessment conclusions

Key to Table 4.5 to 4.8(starting next page)

Genus species (EP): pests for which policy already exists. The outcomes of previous assessments and/or reassessments in this risk analysis are presented in Table 4.6 to 4.8.

Genus species (Acronym for state/territory): state/territory in which regional quarantine pests have been identified

Likelihoods for entry, establishment and spread

N	negligible
EL	extremely low
VL	very low
L	low
M	moderate
H	high
EES	overall likelihood of entry, establishment and spread

Assessment of consequences from pest entry, establishment and spread

PLH	plant life or health
OE	other aspects of the environment
EC	eradication, control
DT	domestic trade
IT	international trade
ENC	environmental and non-commercial
A-G	consequence impact scores are detailed in section 2.2.3
A	Indiscernible at the local level
B	Minor significance at the local level
C	Significant at the local level
D	Significant at the district level
E	Significant at the regional level
F	Significant at the national level
G	Major significance at the national level
URE	unrestricted risk estimate. This is expressed on an ascending scale from negligible to extreme.

Table 4.5 Summary of unrestricted risk estimates for quarantine pests associated with strawberries from Korea for which a full pest risk assessment is conducted

Pest name	Likelihood of					Consequences								URE	
	Entry			Establishment	Spread	EES									
	Importation	Distribution	Overall				Direct			Indirect			Overall		
							PLH	OE	EC	DT	IT	ENC			
Bacteria															
Xanthomonas fragariae	M	L	L	H		M	L	E	A	E	D	D	B	M	L

Table 4.6 Summary of unrestricted risk estimates for quarantine pests associated with strawberries from Korea for which the URE outcome is adopted from previous assessments

Pest name	URE outcome
Thrips [Thysanoptera: Thripidae]	
<i>Frankliniella intonsa</i> (EP)	The URE outcome, which does not achieve the ALOP for Australia, has been adopted from existing policy
<i>Frankliniella occidentalis</i> (EP, NT)	

Table 4.7 Summary of unrestricted risk estimates for quarantine pests associated with strawberries from Korea for which some of the likelihood ratings and consequence estimates are adopted from previous assessments

Pest name	Likelihood of						Consequences						URE
	Entry			Establishment	Spread	EES							
	Importation	Distribution	Overall				Direct			Indirect			Overall
							PLH	OE	EC	DT	IT	ENC	
Spider mites [Trombidiformes: Tetranychidae]													
<i>Tetranychus kanzawai</i> (EP, WA)	M	M	L	H	M	L						M	L
Fungi													

Pest name	Likelihood of						Consequences						URE	
	Entry			Establishment	Spread	EES								
	Importation	Distribution	Overall				Direct			Indirect				Overall
							PLH	OE	EC	DT	IT	ENC		
<i>Monilia polystroma</i> (EP)	VL	H	VL	H	H	VL							M	VL
<i>Monilinia fructigena</i> (EP)														

Table 4.8 Summary of unrestricted risk estimates for quarantine pests associated with strawberries from Korea for which the likelihood ratings and consequence estimates have been determined in a previous assessments

Pest name	URE outcome
Spotted wing drosophila [Diptera: Drosophilidae]	
<i>Drosophila suzukii</i> (EP)	The URE outcome, which does not achieve the ALOP for Australia, has been adopted from existing policy

5 Pest risk management

This chapter provides information on the management of quarantine pests identified with an unrestricted risk level that does not achieve Australia's appropriate level of protection (ALOP). The proposed risk management measures are described in this chapter.

5.1 Pest risk management measures

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests for Australia where they have been assessed to have an unrestricted risk level that does not achieve the ALOP for Australia. In calculating the unrestricted risk, existing commercial production practices in Korea have been considered, as have post-harvest procedures and the packing of fruit.

In addition to Korea's existing commercial production practices for strawberries and minimum border procedures in Australia, specific pest risk management measures, including operational systems, are proposed to achieve the ALOP for Australia.

In this chapter, the Australian Government Department of Agriculture and Water Resources has identified risk management measures that may be applied to consignments of strawberries sourced from Korea. Finalisation of the import conditions may be undertaken with input from the Australian states and territories as appropriate.

5.1.1 Pest risk management for quarantine pests

The pest risk assessments identified the quarantine pests listed in Table 5.1 as having an unrestricted risk level that does not achieve the ALOP for Australia. Therefore, phytosanitary measures are required to manage the risks posed by these pests.

Table 5.1 Risk management measures proposed for quarantine pests for strawberries from Korea

Pest	Common name	Measures
Arthropods		
<i>Frankliniella intonsa</i> (EP)	Eurasian flower thrips	Visual inspection and, if detected, remedial action a
<i>Frankliniella occidentalis</i> (EP, NT)	Western flower thrips	
<i>Tetranychus kanzawai</i> (EP, WA)	Kanzawa spider mite	
<i>Drosophila suzukii</i> (EP)	Spotted wing drosophila	Area freedom b OR Fruit treatment considered to be effective against all life stages of <i>Drosophila suzukii</i> (such as: methyl bromide fumigation or irradiation)
Pathogens		
<i>Xanthomonas fragariae</i>	Angular leaf spot	Area freedom b OR Systems approach

a Remedial action (by QIA) may include applying approved treatment of the consignment to ensure that the pest is no longer viable or withdrawing the consignment from export to Australia. **b** Area freedom may include pest free areas, pest free places of production or pest free production sites. **EP** (existing policy) pests that have previously been assessed by Australia and import policy already exists. **NT** pests of quarantine concern for Northern Territory. **WA** pest of quarantine concern for Western Australia.

Risk management measures proposed here build on the import conditions for strawberries from California, USA and from New Zealand (Department of Agriculture and Water Resources 2016a), as well as for other fruit commodities such as nectarines from China (Australian Government Department of Agriculture and Water Resources 2016) and table grapes from Korea (Biosecurity Australia 2011b), which contain the conditions for the pest species or groups identified in this risk analysis. The import conditions for *D. suzukii* are based on the final pest risk analysis report for *D. suzukii* document (Department of Agriculture 2013).

Trade in strawberries from the California, USA and from New Zealand to Australia has taken place for over twenty years.

The risk management measure options proposed in this draft report are consistent with the existing policies and include:

- visual inspection and remedial action for spider mite and thrips
- area freedom or fruit treatment (such as methyl bromide fumigation or irradiation) for spotted wing drosophila
- area freedom or a systems approach approved by the Australian Government Department of Agriculture and Water Resources for angular leaf spot.

Management for *Frankliniella intonsa*, *Frankliniella occidentalis* and *Tetranychus kanzawai*

To manage the risks from *Frankliniella intonsa* (Eurasian flower thrips), *Frankliniella occidentalis* (western flower thrips) and *Tetranychus kanzawai* (Kanzawa spider mite), the Australian Government Department of Agriculture and Water Resources proposes visual inspection and, if detected, remedial action as a measure for these pests. The objective of the proposed visual inspection is to ensure that any consignments of strawberries from Korea infested with these pests are identified and subjected to appropriate remedial action. The

appropriate remedial action will reduce the risk associated with these pests to at least 'very low', which would achieve the ALOP for Australia.

Proposed measure: Pre-export visual inspection and, if detected, remedial action by QIA.

All strawberry fruit consignments for export to Australia must be inspected by QIA and found free of these quarantine arthropod pests. Export consignments found to contain any of these pests must be subject to remedial action. Remedial action may include withdrawing the consignment from export to Australia or, if available, apply approved treatment of the export consignment to ensure that the pest is no longer viable.

Management for *Drosophila suzukii*

Options recommended to manage this pest in the final pest risk analysis report for *D. suzukii* (Department of Agriculture 2013) include area freedom or fruit treatment considered to be effective against all life stages of *D. suzukii* (such as methyl bromide fumigation or irradiation).

Proposed measure 1: Area freedom

The requirements for establishing pest free areas or pest free places of production or pest free production sites are set out in ISPM 4: *Requirements for the establishment of pest free areas* (FAO 1995) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999).

Drosophila suzukii is widespread in Korea (Asplen et al. 2015; CABI 2016; Lee 1966) as it is native to the East Asia region (Walsh et al. 2011); therefore, pest free areas may not be a viable option for Korea. However, since Korean strawberries for export to Australia are grown in greenhouses, there may be potential to establish pest free production sites.

Should Korea wish to use area freedom as a measure to manage the risk posed by *D. suzukii*, QIA would need to provide Australia with a submission demonstrating area freedom for consideration by the Australian Government Department of Agriculture and Water Resources.

If area freedom could be demonstrated, the likelihood of importation of this pest with strawberries would be reduced to at least 'extremely low'. The restricted risk would then be reduced to at least 'very low', which would achieve the ALOP for Australia.

Proposed measure 2: Methyl bromide fumigation

The Australian Government Department of Agriculture and Water Resources reviewed efficacy data in support of methyl bromide fumigation treatment (listed below), and considered it suitable to manage the risk of *D. suzukii* in strawberries. The treatment is:

- 40 grams per metre cubed for three hours at a pulp temperature of 18 °C or greater.

Proposed measure 3: Irradiation

Irradiation treatment is considered a suitable measure option for *D. suzukii* (Follett, Swedman & Price 2014). The Australian Government Department of Agriculture and Water Resources recommends a treatment schedule of 150 gray minimum absorbed dose, consistent with ISPM 28 Annex 7: *Irradiation treatment for fruit flies of the family Tephritidae (generic)* (FAO 2009). Although lower doses (78 gray) have been shown to induce sterility of all immature life stages associated with fruit, adults can successfully emerge from irradiated pupae. The detection of a sterilised *D. suzukii* post border would result in regulatory actions. A dose of 150 gray would make adult emergence from irradiated fruit an unlikely event.

Management for *Xanthomonas fragariae*

The Australian Government Department of Agriculture and Water Resources proposes area freedom or a systems approach as measures for *Xanthomonas fragariae*.

Proposed measure 1: Area freedom

Area freedom is a measure which may be applied to manage the risk posed by *Xanthomonas fragariae*. The requirements for establishing pest free areas or pest free places of production or pest free production sites are set out in ISPM 4: *Requirements for the establishment of pest free areas* (FAO 1995) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999).

Should Korea wish to use area freedom as a measure to manage the risk posed by these pathogens, QIA would need to provide Australia with a submission demonstrating area freedom for consideration by the Australian Government Department of Agriculture and Water Resources.

If area freedom could be demonstrated, the likelihood of importation of these pathogens with strawberries would be reduced to at least 'extremely low'. The restricted risk would then be reduced to at least 'negligible', which would achieve the ALOP for Australia.

Proposed measure 2: Systems approach

A systems approach that uses the integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the required level of phytosanitary protection, could be used to reduce the risk of *Xanthomonas fragariae* being imported to Australia with consignments of strawberries. More information on a systems approach is set out in ISPM 14: *The use of integrated measures in a systems approach for pest risk management* (FAO 2002).

The Australian Government Department of Agriculture and Water Resources considers a systems approach could be based on area of low pest prevalence, a combination of greenhouse preventative measures and monitoring, and pest control, with post-harvest measures. The approach could be used to progressively reduce the risk of infected strawberries being imported to Australia.

Should Korea wish to use a systems approach as a measure to manage the risk posed by this pathogen, QIA would need to submit a proposal outlining components of the system and how these components will address the risks posed by this pathogen. The Australian Government Department of Agriculture and Water Resources will consider the effectiveness of any system proposed by QIA.

5.1.2 Consideration of alternative measures

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2013), the Australian Government Department of Agriculture and Water Resources will consider any alternative measure proposed by QIA, providing that it manages the target pest to the ALOP for Australia. Evaluation of such measures will require a technical submission from QIA that details the proposed measures and includes suitable information to support the efficacy.

5.2 Operational system for the maintenance and verification of phytosanitary status

A system of operational procedures is necessary to maintain and verify the phytosanitary status of strawberries from Korea. This is to ensure that the proposed risk management measures have been met and are maintained.

5.2.1 A system of traceability to source greenhouses

The objectives of the recommended requirement are to ensure that:

- strawberries are sourced from greenhouses producing commercial quality fruit.
- greenhouses from which strawberries are sourced can be identified so investigation and corrective action can be targeted rather than applying it to all contributing export greenhouses in the event that live pests are intercepted.

It is recommended that QIA establishes a system to enable traceability back to the greenhouse where strawberries for export to Australia are sourced. QIA would be responsible for ensuring that export strawberry growers are aware of the pests of quarantine concern to Australia and control measures.

5.2.2 Registration of packing house and treatment providers and auditing of procedures

The objectives of the procedure are to ensure that:

- strawberries are sourced only from packing houses and treatment providers processing commercial quality strawberries approved by QIA
- treatment providers are capable of applying a treatment that suitably manages the target pests.

Export packing houses are registered with QIA before commencement of harvest each season. The list of registered packing houses must be kept by QIA. QIA is required to ensure the registered packing houses are suitably equipped and have a system in place to carry out the specified phytosanitary activities. Records of QIA's audits would be made available to the Australian Government Department of Agriculture and Water Resources upon request.

Where strawberries undergo treatment prior to export, this process must be undertaken by the treatment providers that have been registered with and audited by QIA for the purpose. Records of QIA's registration requirements and audits are to be made available to the Australian Government Department of Agriculture and Water Resources upon request.

Approval for treatment providers is subject to suitable systems to ensure compliance with the treatment requirements. This may include:

- documented procedures to ensure strawberries are appropriately treated and safeguarded post treatment
- staff training to ensure compliance with procedures
- record keeping procedures
- ensuring facility and equipment is suitable
- QIA's system of oversight of treatment application.

5.2.3 Packaging and labelling

The objectives of this recommended procedure are to ensure that:

- strawberries proposed for export to Australia and all associated packaging is not contaminated by quarantine pests or regulated articles (defined in ISPM 5: *Glossary of phytosanitary terms* (FAO 2015a)).
- unprocessed packaging material, for example unprocessed plant material – which may vector pests identified as not being on the pathway and pests not known to be associated with strawberries – is not imported with the strawberries.
- all wood material used in packaging of strawberries complies with the Australian Government Department of Agriculture and Water Resources conditions
- secure packaging is used during storage and transport to Australia to prevent re-infestation and escape of pests on arrival to Australia. Packaging must meet Australia's general import conditions for fresh fruits and vegetables, available on the Australian Government Department of Agriculture and Water Resources website
- the packaged strawberries are labelled with sufficient identification information for the purposes of trace-back. This may include:
 - For treated product: the treatment facility name/number and treatment identification number.
 - For strawberries where the measures include area freedom: the greenhouse number.
 - For strawberries where phytosanitary measure is applied at the packing house: the packing house number.

Export packing houses and treatment providers (where applicable) must ensure packaging and labelling are suitable to maintain phytosanitary status of the export consignments.

5.2.4 Specific conditions for storage and movement

The objective of this recommended procedure is to ensure that the quarantine integrity of the commodity during storage and movement is maintained.

Strawberries for export to Australia that have been treated and/or inspected must be kept secure and segregated at all times from any fruit for domestic or other markets, untreated/non-pre-inspected product, to prevent mixing or cross-contamination.

5.2.5 Freedom from trash

All strawberries for export must be free from trash (for example, stem and leaf material, seeds, soil, animal matter/parts or other extraneous material) and foreign matter. Freedom from trash will be confirmed by the inspection procedures. Export lots or consignments found to contain trash or foreign matter should be withdrawn from export unless approved remedial action such as reconditioning is made available and applied to the export consignment and then re-inspected.

5.2.6 Pre-export inspection and certification by QIA

The objectives of this recommended procedure are to ensure that:

- Australia's import conditions have been met
- all consignments have been inspected in accordance with official procedures for all visually detectable quarantine pests and other regulated articles (including soil, animal and plant debris) at a standard 600 unit sampling rate per phytosanitary certificate, or equivalent

- an international phytosanitary certificate (IPC) is issued for each consignment upon completion of pre-export inspection and treatment to verify that the relevant measures have been undertaken offshore
- each IPC includes:
 - a description of the consignment (including traceability information)
 - details of disinfestation treatments (for example, methyl bromide fumigation) which includes date, concentration, temperature, duration, and/or attach fumigation certificate (as appropriate)
 - other statements may be required. These may include:
 - certifying the minimum dose of irradiation treatments
 - certifying area freedom/systems approaches or other phytosanitary requirements.

5.2.7 Verification by the Australian Government Department of Agriculture and Water Resources

The objectives of this recommended procedure are to ensure that:

- all consignments comply with Australian import requirements
- consignments are as described on the phytosanitary certificate and quarantine integrity has been maintained.

On arrival in Australia, the Australian Government Department of Agriculture and Water Resources will assess documentation to verify that the consignment is as described on the phytosanitary certificate, that required phytosanitary procedures have been undertaken, and that product security has been maintained.

To verify that biosecurity status of consignments of strawberries from Korea meets Australia's import conditions, the Australian Government Department of Agriculture and Water Resources completes a verification inspection of strawberry consignments on arrival. The Australian Government Department of Agriculture and Water Resources will randomly sample 600 unit per phytosanitary certificate.

The detection of any quarantine pest or regulated article for Australia would require suitable remedial action

5.2.8 Remedial action(s) for non-compliance

The objectives of remedial action(s) for non-compliance are to ensure that:

- any quarantine pest or regulated article is addressed by remedial action, as appropriate
- non-compliance with import requirements is addressed, as appropriate.

Any consignment that fails to meet Australia's import conditions must be subject to a suitable remedial treatment (if one is available), destroyed or re-exported.

Separate to the corrective measures mentioned, there may be other breach actions necessary depending on the specific pest intercepted and the risk management strategy put in place against that pest in the protocol.

If the commodity is repeatedly non-compliant, the Australian Government Department of Agriculture and Water Resources reserves the right to suspend imports (either all imports or imports from specific pathways) and conduct an audit of the risk management systems. Imports

will recommence only when the Australian Government Department of Agriculture and Water Resources is satisfied that appropriate corrective action has been undertaken.

5.3 Uncategorized pests

If an organism, including contaminant pests, is detected on strawberries either in Korea or on-arrival in Australia that has not been categorised, it will require assessment by the Australian Government Department of Agriculture and Water Resources to determine its quarantine status and whether phytosanitary action is required.

Assessment is also required if the detected species was categorised as not likely to be on the import pathway. The detection of any pests of quarantine concern not already identified in the analysis may result in remedial action and/or temporary suspension of trade while a review is conducted to ensure that existing measures continue to provide the appropriate level of protection for Australia.

5.4 Review of processes

5.4.1 Verification of protocol

Prior to or during the first season of trade, the Australian Government Department of Agriculture and Water Resources will verify the implementation of agreed import conditions and phytosanitary measures including registration, operational procedures and treatment providers, where applicable. This may involve representatives from the Australian Government Department of Agriculture and Water Resources visiting areas in Korea that produce strawberries for export to Australia.

5.4.2 Review of policy

The Australian Government Department of Agriculture and Water Resources reserves the right to review the import policy after the first year of trade or when there is reason to believe that the pest or phytosanitary status in Korea has changed.

QIA must inform the Australian Government Department of Agriculture and Water Resources immediately on detection in Korea of any new pests of strawberry that are of potential quarantine concern to Australia.

5.5 Meeting Australia's food laws

Imported food for human consumption must comply with the requirements of the *Imported Food Control Act 1992*, as well as Australian state and territory food laws. Among other things, these laws require all food, including imported food, to meet the standards set out in the Australia New Zealand Food Standards Code (the Code).

The Australian Government Department of Agriculture and Water Resources administers the *Imported Food Control Act 1992*. This legislation provides for the inspection and control of imported food using a risk-based border inspection program, the Imported Food Inspection Scheme. More information on this inspection scheme, including the testing of imported food, is available from the [department's Imported Food Inspection Scheme website](#).

Food Standards Australia New Zealand (FSANZ) is responsible for developing and maintaining the Code, including Standard 1.4.2 - Agvet chemicals. This standard is available on the [Federal Register of Legislation](#) or through the [FSANZ website](#).

Standard 1.4.2 and Schedules 20 and 21 of the Code set out the maximum residue limits (MRLs) and extraneous residue limits (ERLs) for agricultural or veterinary chemicals that are permitted in food, including imported food.

Standard 1.1.1 of the Code specifies that a food must not have, as an ingredient or a component, a detectable amount of an Agvet chemical or a metabolite or a degradation product of the Agvet chemical; unless expressly permitted by the Code.

Anyone may apply to change the Code whether they are an individual, organisation or company. The application process, including the explanation of establishment of MRLs in Australia, is described at the [FSANZ website](#).

6 Conclusion

The findings of this draft risk analysis report for a non-regulated analysis of existing policy for fresh strawberry fruit from the Republic of Korea are based on a comprehensive scientific analysis of relevant literature.

The department considers that the risk management measures proposed in this report will provide an appropriate level of protection against the pests identified as associated with the trade of strawberries from Korea.

Appendix A Initiation and categorisation for pests of fresh strawberry fruit from Korea

The steps in the initiation and categorisation processes are considered sequentially, with the assessment terminating at 'Yes' for column 3 (except for pests that are present, but under official control and/or pests of regional concern) or the first 'No' for columns 4, 5 or 6.

Details of the method used in this risk analysis are given in Section 2: Method for pest risk analysis.

This pest categorisation table does not represent a comprehensive list of all the pests associated with the entire plant of an imported commodity. Reference to soilborne nematodes, soilborne pathogens, wood borer pests, root pests or pathogens, and secondary pests have not been listed, as they are not directly related to the export pathway of fresh commodity fruit and would be addressed by Australia's current approach to contaminating pests.

The department is aware of the recent changes in fungal nomenclature which ended the separate naming of different states of fungi with a pleiomorphic life cycle. However, as the nomenclature for these fungi is in a phase of transition and many priorities of names are still to be resolved, this report uses the generally accepted names and provides alternatively used names as synonyms, where required. As official lists of accepted and rejected fungal names become available, these accepted names will be adopted.

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
ARTHROPODS						
Coleoptera						
<i>Anthonomus bisignifer</i> Schenkling 1874 Synonyms: <i>Anthonomus signatus</i> Kinoshita & Shinkai; <i>Anthonomus bisignatus</i> Roelofs [Curculionidae] Strawberry blossom weevil	Yes (QIA 2015b)	No records found	No. This species feeds on pollen (University of Illinois 2004). The female lays eggs on flowers (EPPO 2014) then damages the stem causing it to hang or fall to the ground (Plantwise 2015; University of Illinois 2004), preventing fruit development. No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Apoderus (Compsapoderus) erythropterus</i> Gmelin 1790 [Attelabidae]	Yes (QIA 2015b)	No records found	No. Species in the <i>Apoderus</i> feed on leaves (Alford 2007). The female rolls the leaf and lays eggs inside. The larvae and pupa develop in the rolled leaves (Gønget 2003). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Auletobius uniformis</i> Roelofs, 1874 [Attelabidae]	Yes (QIA 2015b)	No records found	No. There is little specific information available on this species. However, a closely related species, <i>A. congruus</i> , feeds on flowers including those of strawberry. Adults attack the base of the blossom causing the flower to wilt (Buckell 1943). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Basilepta fulvipes</i> Motschulsky 1860 [Chrysomelidae] Golden-green minute leaf beetle	Yes (QIA 2015b)	No records found	No. This species feeds only on leaves (NPQS 2007; QIA 2015b; USDA-APHIS 2002). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cleoporus variabilis</i> Baly 1874 [Chrysomelidae] Variable leaf beetle	Yes (QIA 2015b)	No records found	No. There is little specific information available on this species. However, whilst other species in the family Chrysomelidae have been known to feed on fruit, flowers and foliage of other plants (Erichsen, McGeoch & Schoeman 1993; Gök, Gül Alsan & Aslam 2005; Murray 1982; Waterson & Urquhart 1995), <i>C. variabilis</i> has only been found on leaves in Korean strawberries (QIA 2015b) and no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Compsapoderus erythrogaster</i> Snelle van Vollenhoven 1865 Synonym: <i>Apoderus erythrogaster</i> Snelle van Vollenhoven 1865 [Attelabidae] Leaf-rolling weevil	Yes (QIA 2015b)	No records found	No. There is little specific information available on <i>C. erythrogaster</i> , but one study did record feeding on foliage of broad-leaved plants (Isagi 1987), and leaf-rolling species in this family are characteristic in their habit of making a 'cradle' out of leaves within which they lay their eggs (Park, Lee & Park 2012), removing the possibility of their eggs being laid on fruit. No records of adults feeding on fruit of any kind have been found.	Assessment not required	Assessment not required	No
<i>Exomala orientalis</i> Waterhouse 1875 [Scarabaeidae] Oriental beetle	Yes (EPPO 2015)	No records found	No. The female lays its eggs near the roots of the plant (Koppenhöfer et al. 2007). The larvae then feed on the root system of strawberries with major infestations damaging the cortex and crown of the plant (LaMondia & Cowles 2005). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Galerucella grisea</i> Joann 1865 [Chrysomelidae] Strawberry leaf beetle	Yes (QIA 2015b)	No records found	No. This species feeds on leaves (Bieńkowski 2010). The female lays its eggs on the stem and leaves of the plant with pupae attaching themselves to plant tissue (Manguin et al. 1993). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Monolepta quadriguttata</i> Motschulsky 1860 [Chrysomelidae]	Yes (QIA 2015b)	No records found	No. There is little specific information available on this species. Species of <i>Monolepta</i> are known to feed on fruit, flowers and foliage (Erichsen, McGeoch & Schoeman 1993; Gök, Gül Alsan & Aslam 2005; Murray 1982) However, in these cases, damage had been described as rendering fruit unmarketable, decreasing the possibility that these damaged fruits would be harvested. Additionally, no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phyllotreta striolata</i> Fabricius 1801 [Chrysomelidae] Cabbage flea-beetle, striped flea beetle	Yes (QIA 2015b)	No records found	No. <i>P. striolata</i> larvae feed on roots. The adult feeds on the stem and foliage, as well as the pods of <i>Brassicae</i> (Wylie 1979). However, no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
Collembola						
<i>Bourletiella hortensis</i> Fitch 1863 [Sminthuridae] Garden springtail	Yes (QIA 2015b)	Yes. Tas., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Diptera						
<i>Bradysia difformis</i> Frey 1948 [Sciaridae] Sciarid fly, fungus gnat	Yes (Shin, Lee & Lee 2012)	No records found	No. The <i>Bradysia</i> genus is generally ground-borne and attacks decaying plant matter and fungi. Whilst there are reports of attacks on healthy plant tissue, including the crown of strawberry plants (Cloyd 2015), no records of adults feeding on fruit of any kind have been found.	Assessment not required	Assessment not required	No
<i>Drosophila melanogaster</i> Meigen 1830 [Drosophilidae] Common vinegar fly, common fruit fly	Yes (CABI 2015a; USDA-APHIS 2002)	Yes. NSW, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Drosophila simulans</i> Sturtevant 1919 [Drosophilidae]	Yes (USDA-APHIS 2002)	Yes. NSW, Qld (Evenhuis 2007), Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Drosophila suzukii</i> Matsumura 1931 [Drosophilidae] Spotted wing drosophila	Yes (The Korean Society of Plant Protection 1986)	No records found	<p>A pest risk assessment for <i>Drosophila suzukii</i> will not be conducted in this risk analysis report for strawberries from Korea.</p> <p>There is existing policy for <i>D. suzukii</i> for all commodities, including strawberries, from all countries (Department of Agriculture 2013). A summary of pest information and previous assessment is presented in Chapter 4 of this report.</p> <p>Further information on existing policy can be found in the ‘Final pest risk analysis report for <i>Drosophila suzukii</i>’, published on 24 April 2013 (Department of Agriculture 2013).</p>			
Hemiptera						
<i>Adelphocoris lineolatus</i> Goeze 1778 [Miridae] Alfalfa plant bug	Yes (Park, Lim & Kim 2014)	No records found	<p>No.</p> <p><i>Adelphocoris lineolatus</i> sucks sap from flowers, young fruit and seed causing reduced yield and germination of seed (Becker 1997). However, they are active insects and will disperse during strawberry harvesting, and are also not known to attack mature strawberry fruit.</p> <p><i>Adelphocoris lineolatus</i> lays small eggs in stems (Chu & Meng 1958) but Korean strawberries are not harvested with an attached peduncle so eggs are unlikely to be transported with fruit.</p>	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Aguriahana triangularis</i> Matsumura 1932 [Cicadellidae] Leafhopper	Yes (National Institute of Agricultural Science and Technology 2005)	No records found	No. <i>Aguriahana triangularis</i> is recorded as a pest of strawberry plants (Dmitriev 2013), however, there is little specific information on this species. <i>Aguriahana</i> spp. are known to suck the cell content from leaves causing white leaf spots (Vollenweider & Günthardt-Goerg 2005). A related species, <i>A. stellulata</i> , feeds on the underside of leaves causing leaf mottling and discoloration (Alford 2007). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Aphis forbesi</i> Weed 1889 [Aphididae] Strawberry root aphid	Yes (QIA 2015b)	No records found	No. Eggs are laid on the pedicels of flowers or the underside of strawberry leaves (Marcovitch 1925). Korean strawberries are harvested without an attached peduncle, removing the possibility of eggs being on the pathway. Once hatched, nymphs puncture the developing leaves feeding on leaf sap and secreting honeydew. This attracts ants who carry nymphs to roots where adult aphids feed on sap (Alford 2007; Marcovitch 1925; Minnesota Department of Agriculture 2015). They have also been reported feeding on strawberry leaves (INRA 1998). However, no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Aphis gossypii</i> Glover 1877 [Aphididae] Melon aphid, cotton aphid	Yes (QIA 2015b)	Yes. NSW, Qld, Tas., Vic., NT, WA, SA (Martyn & Miller 1963; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Arboridia apicalis</i> Nawa, 1913 [Cicadellidae] Grape leafhopper	Yes (QIA 2015b)	No records found	No. This species attacks grape, peach, apple, pear and cherry. Most <i>Arboridia</i> species feed on leaf-mesophyll tissue of deciduous trees and shrubs (Pombo 2001), and <i>A. apicalis</i> adults and nymphs suck sap from the underside of leaves (Li 2004). <i>Arboridia apicalis</i> has been reported feeding on strawberry leaves (QIA 2015b). However, no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Aulacaspis rosae</i> Bouché 1833 [Diaspididae] Rose scale	Yes (QIA 2015b)	Yes. NSW, Tas., Vic., SA (Plant Health Australia 2001). Listed as a Declared Organism (Permitted (section 11)) for WA (Government of Western Australia 2016).	Assessment not required	Assessment not required	Assessment not required	No
<i>Aulacorthum solani</i> Kaltenbach 1843 [Aphididae] Foxglove aphid	Yes (The Korean Society of Plant Protection 1986; Yoon & Choi 1970)	Yes. SA, WA, Vic., NSW, Tas., Qld (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Chaetosiphon (Pentatrichopus) minor</i> Forbes 1884 [Aphididae] Strawberry capitophorus aphid	Yes (QIA 2015b)	No records found	No. Adults feed on foliage. This pest is of economic importance as a vector of strawberry viruses (Blackman & Frazer 1987; Williams & Rings 1980) but no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Empoasca vitis</i> Göthe 1875 [Cicadellidae] Small green leafhopper	Yes (The Korean Society of Plant Protection 1986)	No records found	No. Feeds by inserting mouthparts into leaves; feeding causes scorching (Alford 2007; CABI 2015a; Pavan et al. 1998). This pest is unlikely to remain on the plant during harvesting.	Assessment not required	Assessment not required	No
<i>Macrosiphum euphorbiae</i> Thomas 1878 [Aphididae] Potato aphid	Yes (Lee et al. 2011b)	Yes. Tas., Vic., NSW, WA, Qld, SA, ACT, NT (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Myzus persicae</i> Sulzer 1776 [Aphididae] Green peach aphid, peach curl aphid	Yes (QIA 2015b)	Yes. NSW, Qld, Tas., Vic., NT, WA, SA, ACT (Martyn & Miller 1963; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Nysius plebejus</i> Distant 1883 [Lygaeidae]	Yes (QIA 2015b)	No records found	No. <i>Nysius</i> species feed by piercing plant tissue with their mouthparts, and have been observed feeding on strawberries, causing discolouration, wilting and even death of plants at high infestation levels (Dara 2012). <i>Nysius plebejus</i> has been recorded as a pest of strawberry (Schaefer & Panazzi 2000). There is little other specific information on this species, however, adults and nymphs likely to be disturbed and move away from fruit during harvest, and symptoms of plant damage during high-density infestation are likely to be noticed during harvest.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pseudococcus comstocki</i> Kuwana 1902 [Pseudococcidae] Comstock mealybug	Yes (QIA 2015b)	No records found	No. This species has been found on strawberry leaves and stems but not fruit (QIA 2015b). This species is multivoltine; males mature 2-3 weeks after hatching (Spangler & Agnello 1991) whilst females mature after 6-8 weeks (CABI & EPPO 1981). Due to the variability of their development times, it can be expected that any development stage can be present during harvest. However, <i>P. comstocki</i> feed by extracting phloem sap from leaves and stems (CABI 2016), and Korean strawberries are packed without an attached peduncle, removing the possibility of <i>P. comstocki</i> being on the pathway.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pseudaulacaspis pentagona</i> Targioni-tozzetti 1886 [Diaspididae] White peach scale	Yes (QIA 2015b)	Yes. NSW, Qld, (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2016). However, WA does not require mitigation measures for this pest for other hosts (such as stonefruit) from Australian states where this pest is present (DAFWA 2014; Poole et al. 2011).	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhodobium porosum</i> Sanderson 1900 [Aphididae] Green rose aphid	Yes (QIA 2015b)	Yes. WA, SA, Vic., Tas., Qld (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Trialeurodes packardi</i> Morrill 1903 [Aleyrodidae] Strawberry whitefly	Yes (QIA 2015b)	No records found	No. Eggs are laid on the underside of leaves. Once hatched nymphs puncture the leaf tissue, feeding on leaf sap. When feeding they secrete honeydew, causing sooty mould to grow on the plant (Rao & Welter 1997; Zalom et al. 2014b). This causes foliage to lose vitality leading to reduced fruit production (Picha 1999; Zalom et al. 2014b). <i>Trialeurodes packardi</i> has been reported feeding on strawberry leaves (QIA 2015b). However, no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Trialeurodes vaporariorum</i> Westwood 1856 [Aleyrodidae] Greenhouse whitefly	Yes (QIA 2015b)	Yes. NSW, Qld, Tas., Vic., NT, WA, SA, ACT (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Lepidoptera						

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Acleris comariana</i> Lienig and Zeller 1846 [Tortricidae] Strawberry tortrix moth	Yes (Meijerman & Ulenberg 2000)	No records found	No. Eggs are laid on stipules or petioles and larvae feed on leaves or flowers. On strawberry, flower feeding has been known to lead to distorted fruits developing (Gilligan & Epstein 2014), however, no records of direct association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Acronicta alni</i> Linnaeus 1767 [Noctuidae] Alder moth	Yes (Byun et al. 2010; Roh et al. 2012)	No records found	No. Larvae feed on leaves of fruit trees and other broadleaved forest trees and shrubs. However, little or no significance as fruit pest has been recorded (Alford 1984). <i>Acronicta alni</i> has been reported feeding on strawberry leaves (QIA 2015b). However, no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Acronicta rumicis</i> Linnaeus, 1758 [Noctuidae] Sorrel cutworm, knotgrass moth	Yes (CABI 2015a)	No records found	No. Eggs are laid on lower surfaces of leaves (CABI 2016), larvae feed on leaves of strawberry plants and pupate in soil (Alford 1984). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Agrotis ipsilon</i> Hufnagel 1766 [Noctuidae] Black cutworm, dark sword-grass	Yes (Byun et al. 2010; CABI 2015a)	Yes. ACT, NSW, NT, Qld, SA, Tas., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Agrotis segetum</i> Denis & Schiffermüller 1775 [Noctuidae] Turnip moth	Yes (CABI 2015a)	No records found	No. Larvae feed on roots, stems and leaves (CABI 2015a). Eggs are laid on stems or the ground (INRA 1998). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Anaplectoides prasina</i> Denis & Schiffermüller 1775 [Noctuidae] Green arches, greenish noctuid	Yes (QIA 2015b)	No records found	No. Larvae feed on leaves from a wide range of hardwoods and herbaceous plants including strawberries (Pacific Northwest Moths 2015; QIA 2015b). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Ancylis comptana</i> Frölich 1828 [Tortricidae] Strawberry leaf-roller, Comptan's Ancyliis moth	Yes (Meijerman & Ulenberg 2000)	No records found	No. Larvae feed on upper surface of leaves. They can cause indirect damage to mature fruit via attacking buds, leading to 'catfacing' in mature fruit, (Marshall 1954). Therefore, it is unlikely that infested fruit will be picked and packed for export. There is also a record of <i>A. comptana</i> rolling the calyx against the fruit and feeding underneath, causing the fruit to be unsightly and be rejected during harvest (North Carolina State University 2014).	Assessment not required	Assessment not required	No
<i>Archips breviplicanus</i> Walsingham 1900 Synonym: <i>Archips breviplicana</i> Walsingham 1900 [Tortricidae] Asiatic leafroller	Yes (CABI 2015a; Meijerman & Ulenberg 2000; QIA 2015b)	No records found	No. Larvae feed on lower surface of leaves, buds and the surface of fruit in contact with leaves. They also spin leaves irregularly (Meijerman & Ulenberg 2000). Therefore, they are unlikely to be found on strawberry fruit and damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Archips fuscocupreanus</i> Walsingham 1900 Synonym: <i>Archips fuscocupreana</i> Walsingham 1900 [Tortricidae] Apple tortrix	Yes (Maier 2003; Meijerman & Ulenberg 2000; QIA 2015b)	No records found	No. Young larvae feed on developing leaves. Older larvae eat flowers and may graze on developing fruit (CABI 2015a). Eggs are laid on trunks and limbs of trees (Gilligan & Epstein 2014). Not a pest of mature fruit (CABI 2015a).	Assessment not required	Assessment not required	No
<i>Archips semistructa</i> Meyrick 1937 [Tortricidae] Oak leaf roller	Yes (Meijerman & Ulenberg 2000; QIA 2015b)	No records found	No. There is little specific information available on this species. However, larvae of the tribe Archipini spin and roll leaves. Whilst they may feed on fruit (Common 1990), damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No
<i>Arctia cja</i> Linnaeus 1758 [Arctiinae] Great tiger moth	Yes (QIA 2015b)	No records found	No. Eggs are laid on underside of leaves (Alford 1984) and larvae feed on leaves, with the capability of sequestering toxic compounds from leaves in their body to deter predators (Rothschild, Rowan & Fairbairn 1977). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Artaxa subflava</i> Bremer 1864 Synonym: <i>Euproctis subflava</i> Bremer 1864 [Lymantriidae] Oriental tussock moth	Yes (QIA 2015b)	No records found	No. Larvae of the Lymantriidae are often polyphagous but generally feed on foliage of woody shrubs and trees and less frequently on herbaceous plants (Common 1990). Whilst they are known to feed on fruits (Kristensen 1999), damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No
<i>Autographa nigrisigna</i> Walker 1857 [Noctuidae] Chickpea semilooper, beet worm	Yes (QIA 2015b)	No records found	No. <i>Autographa nigrisigna</i> feeds on leaves (CABI 2015a) and chickpea pods (Ranga Rao & Shanower 1999). <i>Autographa nigrisigna</i> has been reported feeding on strawberry leaves (QIA 2015b) but no records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Celypha cespitana</i> Hübner, 1817 [Tortricidae] Thyme marble	Yes (Byun, Seo & Oh 1998)	No records found	No. Larvae are polyphagous and feed on shoots near roots and on spun or rolled leaves of their host plants, including strawberry (de Prins & Steeman 2010). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Choristoneura lafauryana</i> Ragonot 1875 [Tortricidae] Strawberry leafroller	Yes (Meijerman & Ulenberg 2000)	No records found	No. Larvae feed on the apical leaves of shoots and graze on fruit superficially (Meijerman & Ulenberg 2000). Other species in the genus have been known to feed on maturing fruit (Alford 2007). However, damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No
<i>Cnephasia stephensiana</i> Doubleday 1849 Synonym: <i>Cnephasia cinereipalpana</i> Razowski 1958 [Tortricidae] Grey tortrix	Yes (Byun, Seo & Oh 1998; Meijerman & Ulenberg 2000)	No records found	No. Larvae are pests of cultivated plants in gardens and glasshouses, feeding on leaves and flowers (Meijerman & Ulenberg 2000). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Dysgonia stuposa</i> Fabricius, 1794 Synonym: <i>Parallelia stuposa</i> Fabricius 1794 [Erebidae] Thick-legged moth	Yes (QIA 2015b)	No records found	No. This species is associated with strawberries in Korea (QIA 2015b). Adults of this species only feed on fruit at night and are not associated with fruit during the day. Larvae are only associated with leaves and also feed at night (Hattori 1969), as well as dropping from leaves when threatened. They are therefore unlikely to be near fruit during harvest.	Assessment not required	Assessment not required	No
<i>Haritalodes derogata</i> Fabricius 1775 Synonym: <i>Notarcha derogata</i> Fabricius 1775 [Crambidae] Cotton leafroller	Yes (QIA 2015b)	No records found	No. <i>Haritalodes derogata</i> is associated with leaves on strawberries (QIA 2015b), with feeding causing defoliation and wilting (Plantwise 2015). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Hedya nubiferana</i> (Haworth, 1811) [Tortricidae] marbled orchard tortrix, green Budworm moth	Yes (Meijerman & Ulenberg 2000)	No records found	No. Larvae feed on open buds or in rolled leaves (Meijerman & Ulenberg 2000). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Herminia grisealis</i> Denis & Schiffermüller 1775 Synonym: <i>Herminia nemoralis</i> Fabricius 1775 [Noctuidae] Small fan-foot	Yes (Byun, Seo & Oh 1998; QIA 2015b)	No records found	No. There is little specific information on this species. However, Wolfgang Wagner (2016) observed that <i>H. grisealis</i> were ground-borne and fed on dead and dying leaves from fallen branches. No known association with fruit.	Assessment not required	Assessment not required	No
<i>Lemyra imparilis</i> Butler 1877 [Arctiinae] Mulberry tiger moth	Yes (QIA 2015b)	No records found	No. There is little specific information on this species. However, the larvae of Arctiidae are primarily folivores (Rothschild et al. 1979). In Korea, <i>L. imparilis</i> was found feeding on leaves of strawberry plants (QIA 2015b). No records of attacks on fruit of any kind have been found.	Assessment not required	Assessment not required	No
<i>Lozotaenia forsterana</i> Fabricius 1781 [Tortricidae] Large ivy twist	Yes (Meijerman & Ulenberg 2000)	No records found	No. Larvae roll leaves together and feed on flowers and leaves (Alford 2007; Meijerman & Ulenberg 2000). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Mamestra brassicae</i> Linnaeus 1758 [Noctuidae] Cabbage moth	Yes (CABI 2015a; QIA 2015b)	No records found	No. Early instar <i>M. brassicae</i> larvae feed on foliage. Later instars may bore into fruits but damage is obvious due to size of hole and frass left near the entry. Their larvae grow up to 50 millimetres in length (CABI 2016). Damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No
<i>Mesoleuca albicillata</i> Linnaeus 1758 [Geometridae] Beautiful carpet moth	Yes (QIA 2015b)	No records found	No. This species feeds on leaves of strawberry (QIA 2015b). There is no specific information available on this species, however species in the Geometridae feed on leaves and lay their eggs on twigs or inserted in bark (Alford 2007; Bailey 2007; Kristensen 1999). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Olethreutes orthocosma</i> Meyrick 1931 [Tortricidae]	Yes (Jung & Oh 2012)	No records found	No. There is little specific information available on this species. However, larvae of the Olethreutini sub family are primarily leafrollers feeding on leaves (Alford 2007; Kristensen 1999; Meijerman & Ulenberg 2000).	Assessment not required	Assessment not required	No
<i>Orbona fragariae</i> Vieweg 1790 Synonym: <i>Eupsilia (Orbona) fragariae</i> Vieweg 1790 [Noctuidae] Strawberry cutworm	Yes (QIA 2015b)	No records found	No. There is little specific information on this species. However, the larvae of the family Noctuidae mostly feed on live foliage, flowers, buds and fruits of woody or herbaceous plants (Common 1990; Kristensen 1999). Some species feed on dead leaves or debris (Common 1990). Damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pandemis dumetana</i> Treitschke 1835 [Tortricidae]	Yes (Meijerman & Ulenberg 2000; Roh et al. 2012)	No records found	No. Eggs are laid on the underside of leaves. The larvae then graze on young leaves and blossoms (Alford 2007; Carter 1984; Meijerman & Ulenberg 2000). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Pandemis heparana</i> Denis & Schiffmüller 1776 [Tortricidae] Dark fruit-tree tortrix	Yes (Byun et al. 2010; Byun, Seo & Oh 1998; Jung & Oh 2012; Meijerman & Ulenberg 2000; Roh et al. 2012)	No records found	No. Eggs are laid on the surface of leaves and larvae feed on flowers, fruitlets, young shoots and leaves. Larvae may graze on the surface of ripening fruit of a variety of plants (Alford 2007; Hill 1987; Meijerman & Ulenberg 2000; Yasuda 1972) but damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No
<i>Peridroma saucia</i> Hübner 1808 [Noctuidae] Pearly underwing moth	Yes (CABI 2015a; Jung & Oh 2012; QIA 2015b)	No records found	No. <i>Peridroma saucia</i> larvae are active night feeders and can be found hidden in the soil at the base of plants during the day. During harvest they will not be associated with fruit (University of California 2014).	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Ptycholoma imitator</i> Walsingham 1900 [Tortricidae]	Yes (Meijerman & Ulenberg 2000)	No records found	No. Larvae feed primarily on leaves (Kryzhanovskii 1988). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Ptycholoma lecheana</i> Linnaeus 1758 Synonym: <i>Ptycholoma lecheana circumclusana</i> Christoph 1881 [Tortricidae] Brindled twist	Yes (Meijerman & Ulenberg 2000; Roh et al. 2012)	No records found	No. Larvae are polyphagous, feeding on foliage, buds and spun or rolled leaves (Alford 2007; Meijerman & Ulenberg 2000). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Pylargosceles steganioides</i> Butler 1878 [Geometridae] Two wavy-lined geometrid	Yes (QIA 2015b)	No records found	No. There is little specific information available on this species. However, species in the Geometridae feed on leaves and lay their eggs on twigs or inserted in bark (Alford 2007; Bailey 2007; Kristensen 1999). It has been reported feeding on leaves of strawberry plants (QIA 2015b). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Saturnia pavonia</i> Linnaeus 1758 [Saturniidae] Small emperor moth	Yes (AnimalBase Project Group 2005)	No records found	No. Larvae feed primarily on leaves (Alford 2007). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Scopula superior</i> Butler 1878 [Geometridae] Yellow-rippled white looper moth	Yes (QIA 2015b)	No records found	No. This species is associated with leaves on strawberries (QIA 2015b). There is little specific information available on this species, however, species in the <i>Scopula</i> genus feed primarily on leaves (Bailey 2007; Kristensen 1999). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Sparganothis pilleriana</i> Denis & Schiffermuller 1775 [Tortricidae] Leaf-rolling tortrix	Yes (NPQS 2007)	No records found	No. Eggs are laid on leaves. Larvae may cause substantial direct damage by feeding on shoot tips, leaves, inflorescences and fruit, as well as causing reduction in fruiting (Meijerman & Ulenberg 2000; Pykhova 1968; Schmidt-Tiedemann et al. 2001). It is a known pest of strawberry (Meijerman & Ulenberg 2000), however, damaged fruit would be noticed and not picked during harvest.	Assessment not required	Assessment not required	No
<i>Sprageidus similis</i> Fuessly 1775 Synonym: <i>Euproctis similis</i> Fuessly 1775 [Lymantriidae] Yellow-tail, goldtail, swant moth	Yes (QIA 2015b)	No records found	No. Larvae of the Lymantriidae family generally feed on foliage of woody shrubs and trees (Common 1990), and may cause minor defoliation. They may also damage developing fruitlets (Alford 2007), but are not known to attack mature fruit.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Spilarctia subcarnea</i> Walker 1855 [Arctiinae] White tiger moth	Yes (QIA 2015b)	No records found	No. This species is associated with leaves on strawberries (QIA 2015b). Species in <i>Spilarctia</i> genus lay eggs and feed primarily on leaves (Alford 2007; Kristensen 1999).	Assessment not required	Assessment not required	No
<i>Spilosoma lubricipeda</i> Linnaeus 1758 [Erebidae: Arctiinae] White-ermine moth	Yes (Byun, Seo & Oh 1998; Meijerman & Ulenberg 2000; QIA 2015b; Roh et al. 2012)	No records found	No. The larvae of Arctiinae are polyphagous folivores, and <i>S. lubricipeda</i> as well as many other species in the family are capable of sequestering toxic compounds from leaves for defence against predators (Rothschild et al. 1979). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Spodoptera exigua</i> Hübner 1808 [Noctuidae] Beet armyworm moth	Yes (QIA 2015b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Spodoptera litura</i> Fabricius 1775 [Noctuidae] Cotton leafworm, tobacco cutworm, cluster caterpillar	Yes (Jung & Oh 2012; QIA 2015b)	Yes. ACT, NSW, NT, Qld, Tas., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Stauropus basalis</i> Moore 1877 [Notodontidae]	Yes (Ding, Wu & Zhang 2008; QIA 2015b)	No records found	No. <i>Stauropus basalis</i> larvae are polyphagous but only feed on leaves (Ding, Wu & Zhang 2008). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Syricoris lacunana</i> Denis & Schiffermüller 1775 Synonym: <i>Celypha lacunana</i> Denis & Schiffermüller 1775 [Tortricidae] Dark strawberry tortrix moth	Yes (Meijerman & Ulenberg 2000)	No records found	No. Eggs are laid on the upper side of leaves. Larvae feed primarily on flowers and between spun leaves (Bland, Hancock & Razowski 2014). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Syricoris rivulana</i> Scopoli 1763 Synonym: <i>Celypha rivulana</i> Scopoli 1763 [Tortricidae]	Yes (Meijerman & Ulenberg 2000)	No records found	No. Eggs are laid on terminal shoots and flowers. Larvae feed primarily on flowers, stems, leaves and terminal shoots (Bland, Hancock & Razowski 2014; Meijerman & Ulenberg 2000). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Trichoplusia ni</i> Hübner 1802 [Noctuidae] Cabbage looper	Yes (CABI 2015a)	No records found	No. Larvae feed primarily on leaves (CABI 2015a). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Udea ferrugalis</i> Hübner 1796 [Pyralidae] Rusty-dot pearl	Yes (QIA 2015b)	No records found	No. Larvae feed primarily on the underside of leaves (Alford 2007; QIA 2015b). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Thyatira batis</i> Linnaeus 1758 [Drepanidae] Peach-blossom moth	Yes (Meijerman & Ulenberg 2000; QIA 2015b)	No records found	No. Larvae feed primarily on leaves (Alford 2007; QIA 2015b). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Xestia c-nigrum</i> Linnaeus 1758 [Noctuidae] Spotted cutworm	Yes (QIA 2015b; Roh et al. 2012)	No records found	No. Larvae feed primarily on leaves (CABI 2015a). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
Orthoptera						

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Atractomorpha lata</i> Mochulsky 1866 [Pyrgomorphidae] Differentiate grasshopper	Yes (Kim 2009; QIA 2015b)	No records found	No. <i>Atractomorpha lata</i> is a leaf eating grasshopper (Kim 2009; Ohgushi 2008). It attacks leaves of <i>Solidago altissima</i> (Kajita 1979) and sesame plants during the vegetative and flowering stage (Sintim, Tashiro & Motoyama 2010; Yoshioka, Kadoya & Suda 2010). It has been known to cause feeding damage to buds, young fruits and new leaves on loquats (Souda 2008), however, there is no evidence of damage to strawberry fruit. In addition to this, they are likely to hop away when disturbed, and are therefore highly unlikely to be accidentally collected during harvest.	Assessment not required	Assessment not required	No
Thysanoptera						

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Frankliniella intonsa</i> Trybom 1895 [Thripidae] Eurasian flower thrips, garden thrips, flower thrips	Yes (QIA 2015b)	No records found	Yes. This species oviposits on and feeds on fruit, flowers and leaves, causing suction injury, premature fruit drop and discoloration (CABI 2015a; Plantwise 2015).	Yes. This species is polyphagous and has a wide host range, many of which are present in Australia (CABI 2015a; Plantwise 2015). <i>Frankliniella intonsa</i> is present in Europe, Asia, North America and New Zealand (CABI 2016). Its wide host range and ability to inhabit areas with wide climatic ranges suggests it may establish and spread in Australia.	Yes. This species is polyphagous with a large host range, associated with economic damage of several crop species: asparagus, chrysanthemum, cotton, okra, rice, tomatoes and peas (CABI 2015a). As part of a pest complex, <i>F. intonsa</i> has been associated with economic damage to strawberries by deforming fruit in Italy and the UK, lucerne in former Czechoslovakia and nectarines in Greece (Alford 2007; CABI 2015a).	Yes (EP)

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Frankliniella occidentalis</i> Pergande 1895 [Thripidae] Western flower thrips	Yes (QIA 2015b)	Yes. ACT, NSW, Qld, SA, Tas., Vic. and WA (Plant Health Australia 2001). Prohibited pest in NT (DRDPPIFR NT 2008) and domestic restrictions are in place.	Yes. This species feeds on leaves, stems, flowers and fruit of strawberries causing deformed fruit (Childers 1997). Generally, adults, eggs, larvae and pupae can be carried on the fruit in trade (CABI 2014).	Yes. This thrips has a wide host range, including chrysanthemums, cucurbits, cotton, grapes, citrus and apple (CABI 2012). <i>Frankliniella occidentalis</i> is distributed globally (CABI 2014; Jones 2005; Kirk & Terry 2003) and has successfully spread across most of Australia (Plant Health Australia 2001), indicating that suitable environments exist in NT for this thrips to establish (CABI 2014; Davidson, Butler & Teulon 2006; Jones 2005; Kirk & Terry 2003).	Yes. This is a major pest causing direct damage through feeding and oviposition injury as well as via transmission of at least five tospoviruses. <i>Frankliniella occidentalis</i> feeds on leaves, flowers, stems and fruit (CABI 2014; Davidson, Butler & Teulon 2006; Jones 2005; Stavisky et al. 2002). It can cause secondary bacterial and viral infection to crops causing fruit spoilage (Childers 1997).	Yes (EP, NT)
<i>Haplothrips chinensis</i> Priesner 1933 [Thripidae] Chinese thrips	Yes (QIA 2015b)	No records found	No. Initially recorded in the Republic of Korea on rose, chrysanthemum and other ornamentals (Woo & Paik 1971). Rose is the most common host of this species (Hua, Liu & Chang 1997; Wang 1997). Feeds and oviposits on flowers (Wang 1997). It has been reported on strawberry plants in Korea, but not on the fruit (QIA 2015b).	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Megalurothrips distalis</i> Karny 1913 [Thripidae]	Yes (QIA 2015b)	Yes. Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2016) and domestic restrictions are in place	No. Mostly associated with flowers (Ananthakrishnan 1993; CABI 2016). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No
<i>Scirtothrips dorsalis</i> Hood 1919 [Thripidae] Chilli thrips, strawberry thrips	Yes (CABI & EPPO 2010)	Yes. NSW, NT, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Permitted (section 11)) for WA (Government of Western Australia 2016).	Assessment not required	Assessment not required	Assessment not required	No
<i>Thrips hawaiiensis</i> Morgan 1913 [Thripidae] Hawaiian flower thrips	Yes (QIA 2015b)	Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001; Poole 2008, 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Thrips palmi</i> Karny 1925 [Thripidae] Melon thrips	Yes (QIA 2015b)	Yes. Qld, NT (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2016) and domestic restrictions are in place. Prohibited pest in NT (DPIF 2013) and SA (QDAFF 2014), and domestic restrictions are in place.	No. Found to be unable to complete lifecycle on strawberries when fed strawberry leaves (Kawai 1986).	Assessment not required	Assessment not required	No
Trombidiformes						
<i>Phytonemus pallidus</i> Banks 1899 [Tarsonemidae] Strawberry mite	Yes (Cho, Chung & Lee 1993)	Yes. NSW (Plant Health Australia 2001), Qld, Tas. (CABI 2015a). Listed as a Declared Organism (Permitted (section 11)) for WA (Government of Western Australia 2016).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tetranychus kanzawai</i> Kishida 1927 [Tetranychidae] Tea red spider mite, Kanzawa spider mite	Yes (QIA 2015b)	Yes. NSW (Gutierrez & Schicha 1983), NT (Flechtmann & Knihinicki 2002), Qld (CSIRO 2005; Gutierrez & Schicha 1983), Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2016).	Yes. <i>Tetranychus kanzawai</i> mites and webbing are often found on the underside of leaves and stems of strawberries (Zhang et al. 1996b). They can cause leaf necrosis, mottling and bark discoloration (CABI 2015a) (Plantwise 2015). Flower heads can also become deformed (Gutierrez & Schicha 1983). Unpublished Department of Agriculture and Water Resources data indicate that <i>Tetranychus</i> mites have been intercepted in strawberries from the United States and were found to be hiding under the calyx.	Yes. <i>Tetranychus kanzawai</i> is polyphagous and many of its known hosts are widely available in Australia (CABI 2016; Migeon & Dorkeld 2012), which are present in WA. <i>Tetranychus kanzawai</i> is found in many coastal regions of East Asia (CABI 2016). There may be similar climates between these areas and parts of WA. It has been introduced to and successfully established in Qld and NSW (Gutierrez & Schicha 1983) suggesting suitable conditions for the establishment and spread of <i>T. kanzawai</i> in WA may exist.	Yes. <i>Tetranychus kanzawai</i> is found on a wide range of plant species including crop species such as pear, apples and strawberries (CABI 2016; Gomi & Gotoh 1996; QIA 2015b). <i>Tetranychus kanzawai</i> is subject to quarantine measures in many parts of the world (Navajas et al. 2001).	Yes (EP, WA)
<i>Tetranychus urticae</i> Koch 1835 Synonym: <i>Tetranychus cinnabarinus</i> Boisduval 1867 [Tetranychidae] Two-spotted spider mite	Yes (QIA 2015b)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
GASTROPODA						
Stylommatophora						

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Acusta despecta</i> Sowerby 1839 [Bradybaenidae] Land snail	Yes (QIA 2015b)	No records found	No. Although <i>A. despecta</i> is known to feed on strawberry leaves, stems and fruit in Korea (QIA 2015b), eggs of all <i>Stylommatophora</i> are laid in soil crevices or in leaf litter (Clemente et al. 2008; Faberi et al. 2006), and larvae and adults are likely to be noticed and removed during harvesting and packing.	Assessment not required	Assessment not required	No
<i>Deroceras reticulatum</i> Müller 1774 [Limacidae] Grey field slug, little gray slug	Yes (Kim et al. 2012)	Yes. NSW, Vic., WA, SA and Tas. (Nash & Kimber 2015; Plant Health Australia 2001; Young 1996).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Deroceras varians</i> Adams 1868 [Limacidae] Variable field slug	Yes (QIA 2015b)	No records found	No. Species of <i>Deroceras</i> feed on fruit and the leaves of strawberries (Broadley et al. 1988; Georgiev 2008; Zalom, Bolda & Phillips 2012), and known to damage ripe strawberry fruit, producing rough holes which may lead to secondary infestation by pests such as earwigs, sowbugs, and small beetles (Zalom et al. 2014a). <i>Deroceras varians</i> is known to attack strawberry leaves, stems, flowers and fruit in Korea (QIA 2015b). However, adults are unlikely to remain on harvested fruit during picking and packing, and damage to strawberries render the fruit unmarketable and they will not be packed for export. Eggs of all Stylommatophora are laid in soil crevices or in leaf litter (Clemente et al. 2008; Faberi et al. 2006).	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Incillaria confusa</i> Cockarell [Philomycidae] Japanese native slug	Yes (QIA 2015b)	No records found	No. <i>Incillaria confusa</i> is known to feed on strawberry leaves, stems, flowers and fruit in Korea (QIA 2015b). However, adults are unlikely to remain on harvested fruit during picking and packing. Eggs of all <i>Stylommatophora</i> are laid in soil crevices or in leaf litter (Clemente et al. 2008; Faberi et al. 2006).	Assessment not required	Assessment not required	No
NEMATODA						
Panagrolaimida						
<i>Aphelenchoides fragariae</i> (Ritzema Bos 1891) Christie 1932 [Aphelenchoidae] Strawberry crimp nematode	Yes (QIA 2015b)	Yes. NSW, Qld, SA, Tas., Vic., WA (McLeod, Reay & Smyth 1994).	Assessment not required	Assessment not required	Assessment not required	No
<i>Aphelenchoides ritzemabosi</i> Schwartz 1911 [Aphelenchoidae] Chrysanthemum eelworm	Yes (QIA 2015b)	Yes. NSW, NT, Qld, Tas., Vic., WA (McLeod, Reay & Smyth 1994).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Ditylenchus acris</i> Thorne 1941 [Anguinidae] Strawberry bud nematode	Yes (Kim, Kim & Lee 2005)	No records found	No. <i>Ditylenchus acris</i> lives as ectoparasites on developing buds and leaflets (Kim, Kim & Lee 2005). Not found on mature fruit. Infected fruit buds are unlikely to develop into mature fruit. Infection also causes stunted growth with deformed stems, malformed flowers and fruits (Kim, Kim & Lee 2005), likely leading to the removal or destruction of infected plants from the production site.	Assessment not required	Assessment not required	No
<i>Ditylenchus dipsaci</i> (Kühn 1857) Filip'ev 1936 [Anguinidae] Stem eelworm, stem and bud nematode	Yes (Park et al. 2005)	Yes. NSW, Qld, SA, Tas., Vic., NT (McLeod, Reay & Smyth 1994). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2016).	No. <i>Ditylenchus dipsaci</i> inhabits developing buds internally (Subbotin et al. 2005) and is not known to be present on fruit. <i>Ditylenchus dipsaci</i> damage in strawberry plants results in small distorted leaves with thick petioles (FAO 2015b).	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pratylenchus coffeae</i> (Zimmermann 1898) Filipjev & Schuurmans Stekhoven 1941 [Pratylenchidae] Banana root lesion nematode, coffee root lesion nematode	Yes (QIA 2015b)	Yes. NSW, Qld, SA, Vic., WA (Khair 1986; McLeod, Reay & Smyth 1994).	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus neglectus</i> (Rensch 1924) Filipjev & Schuurmans Stekhoven 1941 [Pratylenchidae] Root lesion nematode	Yes (QIA 2015b)	Yes. NSW, Qld, SA, Tas., Vic., WA (Hay & Pethybridge 2005; McLeod, Reay & Smyth 1994; Riley & Kelly 2002).	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus penetrans</i> (Cobb 1917) Filipjev & Schuurmans Stekhoven 1941 [Pratylenchidae] Cobb's root-lesion nematode	Yes (QIA 2015b)	Yes. NSW, Qld, SA, Tas., Vic., WA (Hay & Pethybridge 2005; McLeod, Reay & Smyth 1994; Riley & Kelly 2002).	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus scribneri</i> Steiner in Sherbakoff & Stanley 1943 [Pratylenchidae] Scribner's root-lesion nematode	Yes (QIA 2015b)	Yes. Qld, NSW, SA, Vic., NT (Khair 1986), WA (Riley & Kelly 2002).	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus thornei</i> Sher & Allen 1953 [Pratylenchidae] Root lesion nematode, Thorne's root lesion nematode	Yes (QIA 2015b)	Yes. NSW, Qld, SA, Vic. (McLeod, Reay & Smyth 1994), Tas. (Hay & Pethybridge 2005), WA (Riley & Kelly 2002).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pratylenchus vulnus</i> Allen & Jensen 1951 [Pratylenchidae] Root lesion nematode, walnut root lesion nematode	Yes (QIA 2015b)	Yes. NSW, Qld, SA, Vic., WA (Khair 1986; McLeod, Reay & Smyth 1994).	Assessment not required	Assessment not required	Assessment not required	No
BACTERIA						
<i>Erwinia amylovora</i> (Burrill 1882) Winslow et al. 1920 [Enterobacteriales: Enterobacteriaceae]	Yes. Reported on apple and pear (Kim & Koo 2009; QIA 2015a).	No records found	No. Strawberry is a minor host (CABI 2015a). The bacterium has been isolated from shoots and leaves of infected strawberry plants in Bulgaria (Antansova et al. 2005; Kabadjova-Hristova et al. 2006). These are the only known reports of this pest infecting strawberries. <i>Erwinia amylovora</i> has never been observed to infect strawberries in Korea (QIA 2015a, b). The department will continue to monitor relevant information relating to this pest, including its status in Korea. The department will re-assess it if new information warrants it.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Erwinia pyrifoliae</i> Kim et al. 1999 [Enterobacteriales: Enterobacteriaceae]	Yes. Reported on Asian pear (CABI 2015a; Kim & Koo 2009; Kim et al. 1999).	No records found	<p>No. Strawberry is a minor host. This species was reported to infect immature strawberry fruit in the Netherlands. (NPPO the Netherlands 2014).</p> <p>This is the only known report of this pest infecting strawberries.</p> <p>There are no records of infection of mature commercial fruit.</p> <p>Further, it is uncertain whether the strains in the Netherlands and in Korea are the same (CABI 2015a; EPPO 2014).</p> <p><i>Erwinia pyrifoliae</i> has never been observed to infect strawberries in Korea (QIA 2015b).</p> <p>The department will continue to monitor relevant information relating to this pest, including its status in Korea. The department will re-assess it if new information warrants it.</p>	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Rhodococcus fascians</i> (Tilford 1936) Goodfellow 1984 [Actinomycetales: Nocardiaceae] Leafy gall disease, cauliflower disease of strawberry.	Yes. Present in the country although not reported on strawberry (Moon, Koo & Yun 2011).	Yes. Australia, NSW (CABI 2015a; Putnam & Miller 2007).	Assessment not required	Assessment not required	Assessment not required	No
<i>Xanthomonas fragariae</i> Kennedy & King 1962 [Xanthomonadales; Xanthomonadaceae] Angular leaf spot	Yes (Kim et al. 2015; Kwon et al. 2010)	No. Eradicated (Australian Government Department of Agriculture 2012; CABI 2015a; CABI & EPPO 1997b; EPPO 1996; Plant Health Australia 2015).	Yes. In addition to leaves, calyx of mature strawberry fruit can also be infected with this pest (Anco & Ellis 2011; Kwon et al. 2010; Peres 2014).	Yes. <i>Xanthomonas fragariae</i> is found in multiple countries over a variety of climatic conditions (CABI & EPPO 1997b; Kim et al. 2015; NPP0 the Netherlands 2013). The pathogen has previously established in areas of NSW, Vic., SA and Qld before being eradicated (Australian Government Department of Agriculture 2012; CABI 2015a; CABI & EPPO 1997b; EPPO 1996).	Yes. <i>Xanthomonas fragariae</i> has caused serious problem for strawberry in many countries where it is present (CABI & EPPO 1997b; Kim et al. 2015; NPP0 the Netherlands 2013). Heavy losses may occur with frequent overhead irrigation (CABI 2015a; Hildebrand, Schroth & Wilhelm 1967). If established in Australia, it would result in substantial costs to eradicate the disease as with previous incursions or in implementing a control programme (McGechan & Fahy 1976; Plant Health Australia 2015; Young et al. 2011).	Yes
MYCOPLASMA						

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Little leaf</i> Possibly an unidentified phytoplasma	Yes (Kim & Koo 2009)	Uncertain as species not specified. Strains of sweet potato little leaf and legume little leaf are present in Australia (Kerr & Gibb 1997; Streten et al. 2005).	No. In infected plants, Phytoplasmas are obligate parasites occupying in the phloem tissue (Lee, Davis & Gundersen-Rindal 2000). Therefore they can be present in all plant parts containing phloem tissue, including the strawberry fruit and seeds in it. The current evidence is that seed to seedling transmission is unlikely (Dickinson, Tuffen & Hodgetts 2013). Transmission from small amounts of the fruit tissue going into waste to new hosts is also unlikely.	Assessment not required	Assessment not required	No
CHROMALVEOLATA						
<i>Phytophthora cactorum</i> (Lebert & Cohn) J. Schröt. [Peronosporales: Peronosporaceae] Phytophthora blight	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phytophthora nicotianae</i> Breda de Haan Synonyms: <i>Phytophthora nicotianae</i> var <i>nicotianae</i> Tucker; <i>Phytophthora parasitica</i> Dastur.; <i>Phytophthora nicotianae</i> var <i>parasitica</i> (Dastur) G. M. Waterh. [Peronosporales: Peronosporaceae] Phytophthora blight	Yes (Kim & Koo 2009; QIA 2015b)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora helicoides</i> (Drechsler) Abad, de Cock, Bala, Robideau, Lodhi & Lévesque Synonym: <i>Pythium helicoides</i> Drechsler [Peronosporales: Pythiaceae] Pythium root rot	Yes (Han et al. 2010)	Yes. WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium sylvaticum</i> W.A. Campb. & F.F. Hendrix [Peronosporales: Pythiaceae] Pythium root rot	Yes (Garzón, Yáñez & Moorman 2007)	Yes. Vic. (Plant Health Australia 2001)	No. <i>Pythium sylvaticum</i> is a soilborne fungus isolated from the roots of strawberries (Nemec 1970; Watanabe, Hashimoto & Sato 1977). It can cause damping off in seedlings and is transmitted through contaminated soil, organic matter (oospores), and water (sporangia) (Spencer 2005). No records of association with strawberry fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pythium torulosum</i> Coker & P. Patt [Peronosporales: Pythiaceae] Pythium root rot	Yes (Chee & Kim 2000; Kim & Park 1997)	Yes. NSW, WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
FUNGI						
<i>Alternaria alternata</i> (Fr.) Keissl. [Pleosporales: Pleosporaceae] Alternaria leaf spot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria tenuissima</i> (Kunze) Wiltshire [Pleosporales: Pleosporaceae] Fruit rot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Athelia rolfsii</i> (Curzi) C.C. Tu & Kimbr. Synonym: <i>Sclerotium rolfsii</i> Sacc. [Atheliales: Atheliaceae] Stem, root, and fruit rot, southern blight	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (as <i>S. rolfsii</i>) (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Botrytis cinerea</i> Pers. [Helotiales: Sclerotiniaceae] Grey mould	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Cladosporium herbarum</i> (Pers.) Link [Capnodiales: Cladosporiaceae] Scab	Yes (Kim & Koo 2009; QIA 2015b)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum acutatum</i> J.H. Simmonds [Phyllachorales: Phyllachoraceae] Black spot of strawberry	Yes (CABI 2015a; Kim & Koo 2009)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Colletotrichum fructicola</i> Prihast., L. Cai & K.D. Hyde Synonym: <i>Glomerella cingulata</i> var. <i>minor</i> Wolenw. [Phyllachorales: Phyllachoraceae] Anthracnose, fruit rot	Yes (Nam et al. 2013)	Yes. Qld (Farr & Rossman 2015; Plant Health Australia 2001). Some of the <i>C. gloeosporioides</i> records in all other States (Plant Health Australia 2001) could be <i>C. fructicola</i> as it has been the case in Korea as well (Nam et al. 2013).	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum gloeosporioides</i> (Penz.) Penz. & Sacc. Synonym: <i>Glomerella cingulata</i> (Stoneman) Spauld. & H. Schrenk. [Phyllachorales: Phyllachoraceae] Anthracnose	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Diplocarpon earlianum</i> (Ellis & Everh.) F.A. Wolf [Helotiales: Dermateaceae] Leaf scorch	Yes (Kim & Koo 2009; QIA 2015b)	Yes. Qld, Vic., WA (Floyd 1994) NSW, SA, Tas. (CABI 2015a; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Discohainesia oenotherae</i> (Cooke & Ellis) Nannf Synonym: <i>Hainesia lythri</i> (Desm.) Höhn [Helotiales: Chaetomellaceae] Tan-bown rot	Yes (Kim & Koo 2009)	Yes. Qld, NSW, Vic., Tas., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Fusarium oxysporum</i> f. sp. fragariae Winks & Y.N. Williams [Hypocreales: Nectriaceae] Fusarium wilt	Yes (Kim & Koo 2009; QIA 2015b)	Yes. Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium</i> sp. [Hypocreales: Nectriaceae] Fusarium wilt	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Ilyonectria destructans</i> (Zinssm.) Rossman, L. Lombard & Crous Synonyms: <i>Cylindrocarpon destructans</i> (Zinssm.) Scholten; <i>Neonectria radicola</i> (Gerlach & L. Nilsson) Mantiri & Samuels [Hypocreales: Nectriaceae] Root rot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Macrophomina phaseolina</i> (Tassi) Goid. [Botryosphaeriales: Botryosphaeriaceae] Charcoal rot	Yes (Farr & Rossman 2015; Kim & Koo 2009)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

<p><i>Monilia polystroma</i> G.C.M.Leeuwen Synonym: <i>Monilinia polystroma</i> (G.C.M. Leeuwen) Kohn [Helotiales: Sclerotiniaceae] Asiatic brown rot</p>	<p>Likely to be present in Korea In Japan a new distinct species (<i>M. polystroma</i>) was identified from isolates previously identified as <i>Monilinia fructigena</i>. It has been suggested that isolates of <i>M. fructigena</i> from other East Asian countries such as China, Russia and Korea should be re-examined to determine whether some of them are in fact isolates of <i>M. polystroma</i> (Chalkley 2010; Van Leeuwen et al. 2002). <i>Monilia polystroma</i> has now been reported from China (Zhu & Guo 2010), and several European countries (CABI 2015b; Di Francesco et al. 2015; Martini et al. 2015; Martini et al. 2014; Petróczy & Palkovics 2009; Vasić, Duduk & Ivanović 2013).</p>	<p>No records found (Plant Health Australia 2001).</p>	<p>Yes. <i>Monilia polystroma</i> is considered to share known hosts with <i>M. fructigena</i> (USDA 2015). Strawberry is susceptible to <i>M. fructigena</i> and is considered a minor host (CABI 2016). <i>Monilia fructigena</i> causes brown rot on fruits resulting in raised light brown pustules on the fruit surface that often expand enclosing the fruit to form a dark, wrinkled, hard mummified fruit (Farr & Rossman 2014; Ogawa, Zehr & Biggs 1995; USDA-APHIS 2004).</p>	<p>Yes. The major hosts, pome and stone fruit species and many other hosts (CABI 2016) are widespread in Australia. Conditions for the natural dispersal of this pathogen (USDA 2015) are available in Australia.</p>	<p>Yes. Brown rot disease, caused by <i>M. fructigena</i>, causes in pome and stone fruit soft decay of fruit flesh and blighting of spurs and blossoms (Mackie, Eyres & Kumar 2005). This results in significant pre- and post-harvest fruit losses and causes considerable economic losses worldwide (Jones 1990; Mackie, Eyres & Kumar 2005; USDA 2015). Similar effects are expected for <i>M. polystroma</i>.</p>	<p>Yes</p>
<p><i>Monilinia fructigena</i> Honey ex Whetzel</p>	<p>Yes (CABI 2015a; Kim & Koo 2009)</p>	<p>No records found (CABI 2015a; Plant</p>	<p>Yes. Strawberry is susceptible to</p>	<p>Yes. The major hosts, pome and stone fruit</p>	<p>Yes. <i>Monilinia fructigena</i> causes brown rot</p>	<p>Yes</p>

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Helotiales: Sclerotiniaceae] Brown rot		Health Australia 2001).	<i>M. fructigena</i> and is considered a minor host (CABI 2016). <i>Monilinia fructigena</i> causes brown rot on fruits resulting in raised light brown pustules on the fruit surface that often expand enclosing the fruit to form a dark, wrinkled, hard mummified fruit (Farr & Rossman 2014; Ogawa, Zehr & Biggs 1995; USDA-APHIS 2004).	species and many other hosts (CABI 2016) are widespread in Australia. Conditions for the natural dispersal of the pathogen (USDA 2015) are available in Australia.	disease in pome and stone fruit which is the soft decay of fruit flesh and blighting of spurs and blossoms (Mackie, Eyres & Kumar 2005). This results in significant pre- and post-harvest fruit losses on susceptible hosts and results in considerable economic losses worldwide (Jones 1990; Mackie, Eyres & Kumar 2005; USDA 2015).	
<i>Mycosphaerella fragariae</i> (Tul. & C. Tul.) Lindau [Capnodiales: Mycosphaerellaceae] Leaf spot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. NSW, Qld, SA, Vic., WA, Tas. (CABI & EPPO 1982; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Phomopsis obscurans</i> (Ellis & Everh.) B. Sutton [Diaporthales: Diaporthaceae] Leaf blight, fruit rot	Yes (Kim & Koo 2009)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Phyllosticta fragariicola</i> Roberge ex Desm. [as ' <i>fragaricola</i> '] [Botryosphaeriales: Phyllostictaceae] Leaf spot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. Qld (Plant Health Australia 2001) (as ' <i>fragaricola</i> ') and SA (Farr & Rossman 2015).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Podosphaera aphanis</i> (Wallr.) U. Braun & S. Takam. Synonyms: <i>Sphaerotheca aphanis</i> (Wallr.) U. Braun, <i>Sphaerotheca macularis</i> f. sp. <i>fragariae</i> (Harz) Jacz.; <i>Sphaerotheca macularis</i> (Wallr.) Magnus [Erysiphales: Erysiphaceae] Powdery mildew	Yes (Kim & Koo 2009; QIA 2015b) (as <i>S. aphanis</i>).	Yes. Qld, Vic., SA (Plant Health Australia 2001) WA (CABI & EPPO 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhizoctonia fragariae</i> S.S. Hussain & W.E. McKeen [Cantharellales: Ceratobasidiaceae] Rhizoctonia bud rot; black root rot of strawberry	Yes (Kim & Koo 2009; QIA 2015b)	Yes. WA (Fang, Finnegan & Barbetti 2013). Perhaps in other states too because there are over 900 <i>Rhizoctonia</i> sp. records in ACT, NSW, Qld, SA, Tas., Vic. and WA, including some on strawberry (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhizopus stolonifer</i> (Ehrenb.) Vuill Synonym: <i>Rhizopus nigricans</i> Ehrenb. [Mucorales: Rhizopodaceae] Fruit rot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Sclerotinia sclerotiorum</i> (Lib.) de Bary [Helotiales: Sclerotiniaceae] Sclerotinia rot	Yes (Kim & Koo 2009; QIA 2015a)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Septoria fragariae</i> Desm. [Capnodiales: Mycosphaerellaceae] Leaf spot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. Australia (Maas 1984).	Assessment not required	Assessment not required	Assessment not required	No
<i>Thanatephorus cucumeris</i> (A.B. Frank) Donk Synonym: <i>Rhizoctonia solani</i> J.G. Kühn [Cantharellales: Ceratobasidiaceae] Rhizoctonia bud rot, root rot, fruit rot	Yes (Kim & Koo 2009; QIA 2015b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (as <i>R. solani</i>) (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Verticillium dahliae</i> Kleb. [Not Assigned: Plectosphaerellaceae] Veticillium wilt	Yes (Kim & Koo 2009) and strawberry is a main host (CABI 2015a).	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Kirkby & Smith 2015; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
VIRUSES						
<i>Alfalfa mosaic virus</i> [Bromoviridae: Alfamovirus]	Yes (QIA 2015b)	Yes. NSW, Qld, SA, Tas., Vic., WA (CABI 2015a).	Assessment not required	Assessment not required	Assessment not required	No
<i>Apple mosaic virus</i> [Bromoviridae: Ilarvirus]	Yes (Lee et al. 2002)	Yes. Qld, SA, Vic. (Plant Health Australia 2001) WA (Government of Western Australia 2016) Tas. (CABI 2001; Grimova et al. 2016).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cucumber mosaic virus</i> [Bromoviridae: Cucumovirus]	Yes (CABI & EPPO 2002; Kim et al. 2014)	Yes. NSW, Qld, SA, Tas., Vic., WA (CABI 2015a; CABI & EPPO 2002; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
<i>Strawberry crinkle virus</i> [Rhabdoviridae: Cytorhabdovirus]	Yes (QIA 2015b)	Yes. NSW, Qld, Tas., Vic. (CABI 2015a), WA (McLean & Price 1984).	Assessment not required	Assessment not required	Assessment not required	No
<i>Strawberry mild yellow edge virus</i> (SMYEV) [Alpaflexiviridae: Potexvirus]	Yes (QIA 2015b)	Yes. Qld, Tas., Vic., WA (Büchen-Osmond et al. 1988; CABI 2015a).	Assessment not required	Assessment not required	Assessment not required	No
<i>Strawberry mottle virus</i> (SMoV) [Secoviridae: Unassigned]	Yes (Choi et al. 2009; Kim & Koo 2009)	Yes. Vic. (Plant Health Australia 2001) Qld (CABI 2015a).	Assessment not required	Assessment not required	Assessment not required	No
<i>Strawberry pallidosis associated virus</i> (SPaV) [Closteroviridae: Crinivirus]	Yes (Choi et al. 2009; Kim & Koo 2009)	Yes. Australia (Frazier & Stubbs 1969) Vic. (Constable et al. 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Strawberry vein banding virus</i> (SVBV) [Caulimoviridae: Caulimovirus]	Yes (Choi et al. 2009)	Yes. NSW, Tas., Vic. (CABI 2015a; Constable et al. 2010).	Yes. <i>Strawberry vein banding virus</i> (SVBV) is recorded in vegetative material including leaves and runners (CABI & EPPO 1997a; Choi et al. 2009; EFSA 2014). As SVBV infects systemically, the calyx could contain the virus (EFSA 2014)	Yes. SVBV is established in some states in Australia (NSW, Tas. and Vic.) (CABI 2015a; Constable et al. 2010). SVBV is vectored by aphids (CABI & EPPO 1997a; EFSA 2014). Aphids of the genus <i>Chaetosiphon</i> are the main vectors including <i>C. fragaefolii</i> , <i>C. thomasi</i> , and <i>C. tetrarhodum</i> which have been recorded in Australia (CABI & EPPO 1997a; Plant Health Australia 2001; Tzanetakis & Martin 2013).	No. Strawberry is the only recorded host for SVBV (EFSA 2014; Tzanetakis & Martin 2013). SVBV does not cause severe symptoms and can be almost symptomless in modern strawberry cultivars. However when plants are infected with multiple strawberry viruses, symptoms can be more severe (EFSA 2014; Tzanetakis & Martin 2013).	No

Pest	Present in Korea	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tomato ringspot virus</i> [Comovirinae: Nepovirus] Ringspot of tomato	Yes (CABI 2015a; CABI & EPPO 2012) Recorded on lilies in Korea (Kim & Koo 2009; Lee et al. 1996).	No. Eradicated (CABI 2015a; CABI & EPPO 2012).	No. No records of <i>Tomato ringspot virus</i> have been found on strawberries in Korea, only on lilies (Kim & Koo 2009; Lee et al. 1996; QIA 2016). Supporting this, Korea currently tests strawberry seed coming into the country for this virus (QIA 2016). The department will continue to monitor relevant information relating to this pest, including its status in Korea. The department will re-assess it if new information warrants it.	Assessment not required	Assessment not required	No

Glossary

Term or abbreviation	Definition
Achene	A term describing the small, dry and indehiscent seeds, for instance, on the outside of strawberry fruit.
Additional declaration	A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2015a).
Anamorph	An asexual stage in the life cycle of a fungus, also known as the imperfect state of a fungus.
Appropriate level of protection (ALOP)	The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory (WTO 1995).
Appropriate level of protection (ALOP) for Australia	The <i>Biosecurity Act 2015</i> defines the appropriate level of protection (or ALOP) for Australia as a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risks to very low, but not to zero.
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2015a).
Area of low pest prevalence	An area, whether all of a country, part of a country, or all parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (FAO 2015a).
Arthropod	The largest phylum of animals, including the insects, arachnids and crustaceans.
Asexual reproduction	The development of new individual from a single cell or group of cells in the absence of meiosis.
Biosecurity	The prevention of the entry, establishment or spread of unwanted pests and infectious disease agents to protect human, animal or plant health or life, and the environment.
Biosecurity measures	The <i>Biosecurity Act 2015</i> defines biosecurity measures as measures to manage any of the following: biosecurity risk, the risk of contagion of a listed human disease, the risk of listed human diseases entering, emerging, establishing themselves or spreading in Australian territory, and biosecurity emergencies and human biosecurity emergencies.
Biosecurity risk	The <i>Biosecurity Act 2015</i> refers to biosecurity risk as the likelihood of a disease or pest entering, establishing or spreading in Australian territory, and the potential for the disease or pest causing harm to human, animal or plant health, the environment, economic or community activities.
Biosecurity risk analysis (BIRA)	The <i>Biosecurity Act 2015</i> defines a BIRA as an evaluation of the level of biosecurity risk associated with particular goods, or a particular class of goods, that may be imported, or proposed to be imported, into Australian territory, including, if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or the class of goods, to a level that achieves the ALOP for Australia. The risk analysis process is regulated under legislation.
Calyx	A collective term referring to all of the sepals in a flower.
Cambium	A layer of meristematic tissue which produces secondary tissue, leading to growth.
Consignment	A quantity of plants, plant products or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) (FAO 2015a).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2015a).
Crawler	Intermediate mobile nymph stage of certain Arthropods.

Term or abbreviation	Definition
Crown	The above-ground parts of a plant consisting of stem, leaves and reproductive organs.
Daughter plant	Strawberry plants produced asexually on stolons.
Desiccation	The process of tissue becoming dry.
Diapause	Period of suspended development/growth occurring in some insects, in which metabolism is decreased.
Disease	A condition of part or all of an organism that may result from various causes such as infection, genetic defect or environmental stress.
The department	The Australian Government Department of Agriculture and Water Resources.
ELISA	Enzyme-linked immunosorbent assay
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2015a).
Endemic	Belonging to, native to, or prevalent in a particular geography, area or environment.
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2015a).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2015a).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2015a).
Flower bud differentiation	A term used to describe flower development following initiation.
Fumigation	A method of pest control that completely fills an area with gaseous pesticides to suffocate or poison the pests within.
Genus	A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.
Goods	The <i>Biosecurity Act 2015</i> defines goods as an animal, a plant (whether moveable or not), a sample or specimen of a disease agent, a pest, mail or any other article, substance or thing (including, but not limited to, any kind of moveable property).
Greenhouse	An enclosed structure (clear glass or plastic) for protected plant and fruit production.
Host	An organism that harbours a parasite, mutual partner, or commensal partner, typically providing nourishment and shelter.
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2015a).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2015a).
Infection	The internal 'endophytic' colonisation of a plant, or plant organ, and is generally associated with the development of disease symptoms as the integrity of cells and/or biological processes are disrupted.
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2015a).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (FAO 2015a).
Instar	An insect at a developmental form between moults.
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2015a).

Term or abbreviation	Definition
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2015a).
International Plant Protection Convention (IPPC)	The IPPC is an international plant health agreement, established in 1952, that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. The IPPC provides an international framework for plant protection that includes developing International Standards for Phytosanitary Measures (ISPMs) for safeguarding plant resources.
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPCC (FAO 2015a).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2015a).
Larva	A juvenile form of animal with indirect development, undergoing metamorphosis (for example, insects or amphibians).
Mature fruit	Commercial maturity is the start of the ripening process. The ripening process will then continue and provide a product that is consumer-acceptable. Maturity assessments include colour, starch, index, soluble solids content, flesh firmness, acidity, and ethylene production rate.
Mesophyll	A layer of cells containing chlorophyll within a leaf.
Mortality	The total number of organisms killed by a particular disease.
Moult	Shedding of exoskeleton to allow new growth. Also known as ecdysis.
Multivoltine	A species with more than two generations a year.
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2015a).
Non-regulated risk analysis	Refers to the process for conducting a risk analysis that is not regulated under legislation (<i>Biosecurity import risk analysis guidelines 2016</i>).
Nymph	The immature form of some insect species that undergoes incomplete metamorphosis. It is not to be confused with larva, as its overall form is already that of the adult.
Official control	The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests (FAO 2015a).
Pathogen	A biological agent that can cause disease to its host.
Pathway	Any means that allows the entry or spread of a pest (FAO 2015a).
PCR	Polymerase chain reaction
Peduncle	A stalk or stem supporting/bearing a flower or fruit.
Petiole	A stalk or stem supporting/bearing a leaf.
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2015a).
Pest categorisation	The process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest (FAO 2015a).
Pest free area (PFA)	An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (FAO 2015a).
Pest free place of production	Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2015a).
Pest free production site	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period and that is

Term or abbreviation	Definition
	managed as a separate unit in the same way as a pest free place of production (FAO 2015a).
Pest risk analysis (PRA)	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it (FAO 2015a).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences (FAO 2015a).
Pest risk assessment (for regulated non-quarantine pests)	Evaluation of the probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact (FAO 2015a).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2015a).
Pest risk management (for regulated non-quarantine pests)	Evaluation and selection of options to reduce the risk that a pest in plants for planting causes an economically unacceptable impact on the intended use of those plants (FAO 2015a).
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information (FAO 2015a).
Phloem	In vascular plants, the tissue that carries organic nutrients to all parts of the plant where needed.
Phytosanitary certificate	An official paper document or its official electronic equivalent, consistent with the model of certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2015a).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2015a).
Phytosanitary measure	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2015a). The term 'risk management measure' has been used in the risk analysis as this term is used in the <i>Biosecurity Act 2015</i> .
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2015a).
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2015a).
Polyphagous	Feeding on a relatively large number of hosts from different plant family and/or genera.
PRA area	Area in relation to which a pest risk analysis is conducted (FAO 2015a).
Practically free	Of a consignment, field or place of production, without pests (or a specific pests) in numbers or quantities in excess of those that can be expected to result from, and be consistent with good cultural and handling practices employed in the production and marketing of the commodity (FAO 2015a).
Punnet	Packaging for strawberries.
Pupa	An inactive life stage that only occurs in insects that undergo complete metamorphosis, for example butterflies and moths (Lepidoptera), beetles (Coleoptera) and bees, wasps and ants (Hymenoptera).
Quarantine	Official confinement of regulated articles for observation and research or for further inspection, testing or treatment (FAO 2015a).

Term or abbreviation	Definition
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2015a).
Regulated article	Any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2015a).
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO 2015a).
Regulated pest	A quarantine pest or a regulated non-quarantine pest (FAO 2015a).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Risk analysis	Refers to the technical or scientific process for assessing biosecurity risk and the development of risk mitigation measures (<i>Biosecurity import risk analysis guidelines 2016</i>).
RT-PCR	Reverse transcription polymerase chain reaction
Runner	A stem growing horizontally from the crown that takes root and produces daughter plants. Also known as stolon.
Saprophyte	An organism deriving its nourishment from dead organic matter.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2015a).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Stolon	A horizontal plant stem that takes root along its length to form new plants. Also known as runners.
Surveillance	An official process which collects and records data on pest occurrence or absence by surveying, monitoring or other procedures (FAO 2015a).
Systems approach(es)	The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests.
Trash	Soil, splinters, twigs, leaves, and other plant material, other than fruit stalks.
Treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation (FAO 2015a).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.
Vector	An organism that does not cause disease itself, but which causes infection by conveying pathogens from one host to another.
Viable	Alive, able to germinate or capable of growth.
Xylem	The vascular tissue of a plant which transports water.

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