Australian Government

Department of Agriculture, Fisheries and Forestry

Draft report for the non-regulated analysis of existing policy for fresh lychee fruit from Taiwan and Vietnam

November 2012

Ownership of intellectual property rights

Creative Commons licence

This publication (and any material sourced from it) should be attributed as:

> Department of Agriculture, Fisheries and Forestry (2012), *Draft report for the non-regulated analysis of existing policy for fresh lychee fruit from Taiwan and Vietnam* CC BY 3.0.

Cataloguing data

Department of Agriculture, Fisheries and Forestry (2012), *Draft report for the non-regulated analysis of existing policy for fresh lychee fruit from Taiwan and Vietnam,* Department of Agriculture, Fisheries and Forestry, Canberra.

Internet

Draft report for the non-regulated analysis of existing policy for fresh lychee fruit from Taiwan and Vietnam is available at daff.gov.au.

Inquiries regarding the licence and any use of this document should be sent to: copyright@daff.gov.au.

Disclaimer

The picture of newly harvested fresh lychee fruit on the front cover was taken in a lychee orchard in Nantou County, Taiwan by the Department of Agriculture, Fisheries and Forestry in June 2012.

Submissions

This draft report has been issued to give all interested parties an opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors. Any comments should be submitted to the Department of Agriculture, Fisheries and Forestry within the comment period stated in the related Biosecurity Advice on the website. The draft report will then be revised as necessary to take account of the comments received and a final report prepared.

Comments on the draft report should be submitted to:

Biosecurity Plant
Department of Agriculture, Fisheries and Forestry
GPO Box 858
CANBERRA ACT 2601
AUSTRALIA

Telephone	+61 2 6272 3933
Facsimile	+61 2 6272 3307
Email	plant@daff.gov.au
Website	daff.gov.au/biosecurity

Contents

List of tables

List of figures

Figure 1 Map of Australia

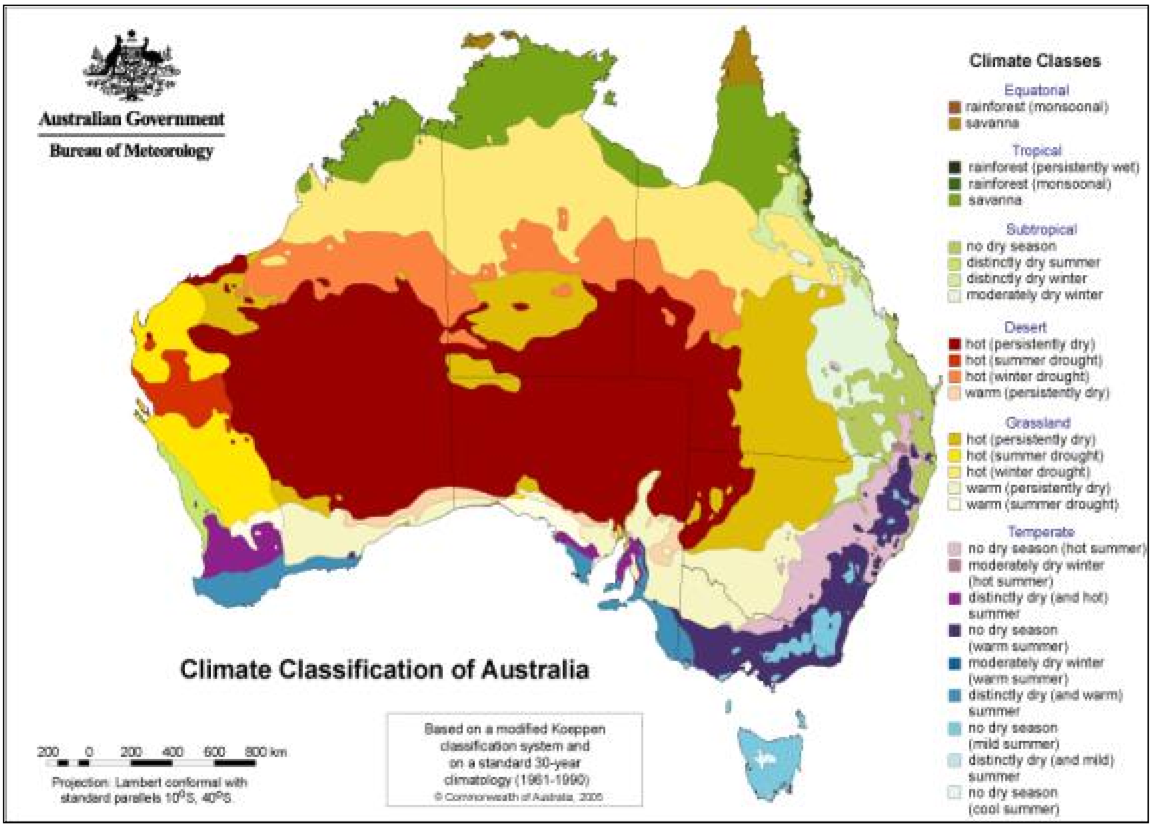

Figure 2 A guide to Australia's bio-climatic zones

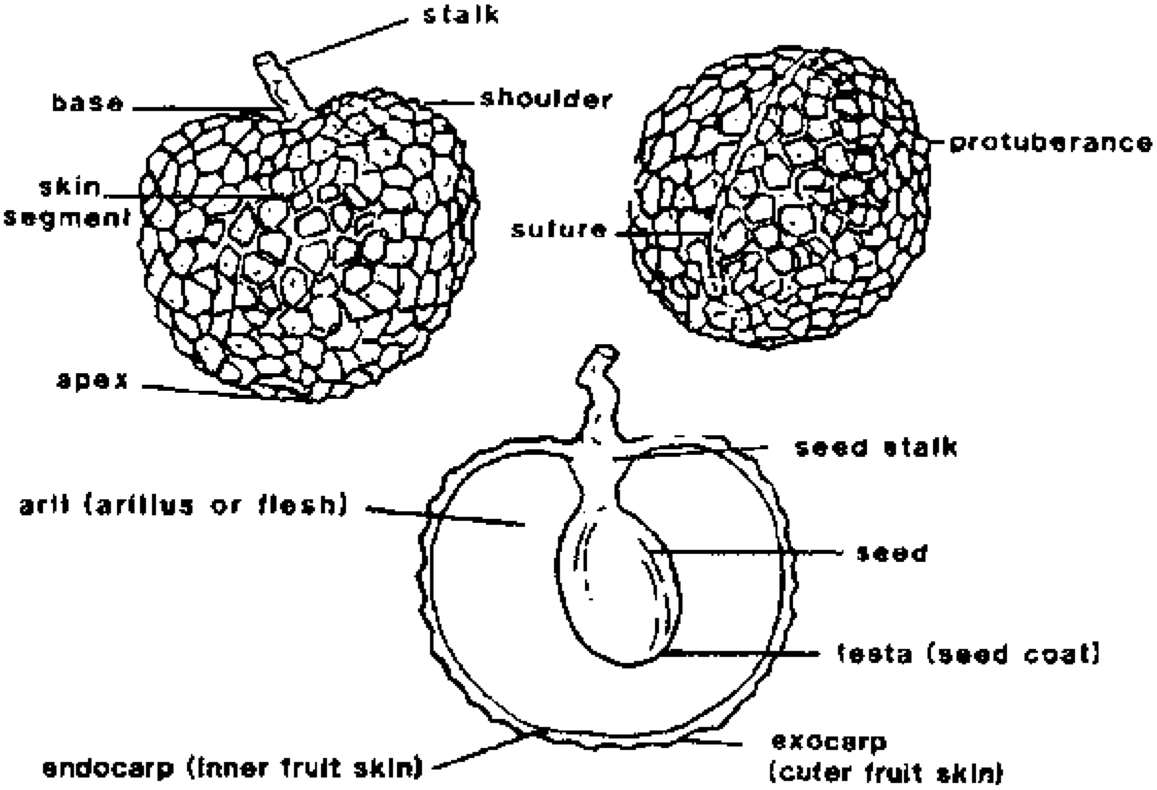

Figure 3 **Diagram of lychee fruit (Menzel 2002)**

Figure 4 **Lychee production areas in Australia (ALGA 2012)**

Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALGA	Australian Lychee Growers Association Inc.
ALOP	Appropriate level of protection
AQIS	Australian Quarantine and Inspection Service
BAPHIQ	Bureau of Animal and Plant Health Inspection and Quarantine, Taiwan
CABI	CAB International, Wallingford, UK
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
EP	Existing policy
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practice
ICON	DAFF Import conditions database
IPC	International Phytosanitary Certificate
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRA	Import Risk Analysis
ISPM	International Standard for Phytosanitary Measures
MARD	Ministry of Agriculture and Rural Development, Vietnam
NPPO	National Plant Protection Organisation
NT	Northern Territory
PPD	Plant Protection Department, Vietnam
PRA	Pest risk analysis
Qld	Queensland
SA	South Australia
SPS	Sanitary and Phytosanitary
TW	Taiwan
USA	United States of America
VHT	Vapour heat treatment
VietGAP	Vietnamese Good Agricultural Prac tices
VN	Vietnam
WA	Western Australia
WTO	World Trade Organization

Abbreviations of units

Term or abbreviation	Definition
ºC	degree Celsius
cm	centimetre
ft	foot
g	gram
Gy	gray
ha	hectare
kg	kilogram
m	metre
mm	millimetre
t	tonne

Summary

The Australian Government Department of Agriculture, Fisheries and Forestry has prepared this draft report for the non-regulated analysis of existing policy to assess proposals from Taiwan and Vietnam for market access to Australia for fresh lychee fruit.

Australia permits the importation of fresh lychee fruit from the People's Republic of China and Thailand for human consumption, provided they meet Australian quarantine requirements.

This draft report proposes that the importation of fresh lychee fruit from all commercial production areas of Taiwan and Vietnam be permitted, subject to a range of quarantine conditions.

This draft report identifies pests that require quarantine measures to manage risks to a very low level in order to achieve Australia's appropriate level of protection (ALOP). The pests requiring measures are melon fly, oriental fruit fly, litchi fruit borer, lepelleyi mealybug, intercepted mealybug, coffee mealybug, litchi mealybug, passionvine mealybug, citriculus mealybug, Jack Beardsley mealybug.

The recommended quarantine measures take account of regional differences within Australia. Only one pest requiring risk mitigation, passionvine mealybug, has been identified as a regional quarantine pest for Western Australia.

This draft report proposes a combination of risk management measures and operational systems that will reduce the risk associated with the importation of fresh lychee fruit from Taiwan and Vietnam into Australia to achieve Australia's ALOP, specifically:

- pest management measures including:
    - cold disinfestation treatment or vapour heat treatment (VHT) for the management of fruit flies
    - cold disinfestation treatment; or orchard control, inspection and remedial action; or orchard freedom for the management of litchi fruit borer
    - visual inspection and remedial action, if needed, for the management of mealybugs or
    - irradiation for the identified quarantine pests.
- an operational system for the maintenance and verification of the phytosanitary status of fresh lychee fruit, including:
    - registration of export orchards and packing houses and auditing of procedures
    - registration of treatment facilities and auditing of procedures
    - packaging and labelling requirements
    - specific conditions for storage and transport
    - pre-export phytosanitary inspection and certification by Taiwan's Bureau of Animal and Plant Health Inspection and Quarantine (BAPHIQ) or Vietnam's Plant Protection Department (PPD)
    - on-arrival phytosanitary inspection, remedial action when required, and clearance by the Department of Agriculture, Fisheries and Forestry (DAFF).

This draft report contains details of the risk assessments for the quarantine pests and the proposed quarantine measures in order to allow interested parties to provide comments and submissions to DAFF within the 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[1] 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 import risk analysis (IRA) process is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the risks that could be associated with proposals to import new products into Australia. If the risks are found to exceed Australia's appropriate level of protection (ALOP), risk management measures are proposed to reduce the risks to an acceptable level. But, if it is not possible to reduce the risks to an acceptable level, then no trade will be allowed.

Successive Australian Governments have maintained a conservative, but not a zero-risk, approach to the management of biosecurity risks. This approach is expressed in terms of Australia's ALOP, 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 IRAs are undertaken by DAFF using technical and scientific experts in relevant fields, and involves consultation with stakeholders at various stages during the process. DAFF provides recommendations for animal and plant quarantine policy to Australia's Director of Animal and Plant Quarantine (the Secretary of the Department of Agriculture, Fisheries and Forestry, DAFF). The Director, or delegate, is responsible for determining whether or not an importation can be permitted under the *Quarantine Act 1908*, and if so, under what conditions. DAFF is responsible for implementing appropriate risk management measures.

More information about Australia's biosecurity framework is provided in Appendix C of this report and in the *Import Risk Analysis Handbook 2011* located on the DAFF website www.daff.gov.au.

1.2 This non-regulated analysis of existing policy

1.2.1 Background

Taiwan

On 27 June 2003, Taiwan's Bureau of Animal and Plant Health Inspection and Quarantine (BAPHIQ) formally requested market access for fresh lychee fruit through the Australian Office, Taipei (formerly, Australian Commerce and Industry Office) and provided a document regarding vapour heat treatment disinfestation of oriental fruit fly in lychee. Initial information on lychee cultivars, cultivation and a pest list were provided in June 2004. Additional information on Taiwan's lychee production practices was provided on 1 June 2012.

---

[1] A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products.

Vietnam

On 12 September 2003, through an Australian company, Vietnam's Plant Protection Department (PPD), Ministry of Agriculture & Rural Development (MARD) formally requested market access for fresh lychee fruit to Australia. Limited information on lychees in Vietnam and a list of lychee pests were attached. A revised submission was provided on 5 November 2003. However, a valid technical market access submission for lychees was only provided directly by PPD in October 2010, after advice by DAFF on 11 September 2008 that information on the existing commercial lychee production practices was lacking.

On 20 December 2011, DAFF formally announced the commencement of a non-regulated analysis of existing policy for fresh lychee fruit from Taiwan and Vietnam.

1.2.2 Scope

The access requests from Taiwan and Vietnam are to be considered together in this report.

The scope of this non-regulated analysis is to consider the quarantine risk that may be associated with the importation of commercially produced fresh lychee fruit (*Litchi chinensis* Sonn.), free from trash, from Taiwan and Vietnam, for human consumption in Australia.

In this analysis fresh lychee fruit is defined as fruit with the stalk but not other plant parts (Fig. 4). This risk analysis covers all commercially produced fresh lychee fruit of all cultivars (also referred to as varieties) and the provinces or regions of Taiwan and Vietnam in which they are grown for export.

1.2.3 Existing policy

International policy

Import policy exists for fresh lychee fruit imported from the People's Republic of China and Thailand (DAFF 2004b) and trade has occurred since 2004. Fresh lychee fruit from South Africa are also permitted to be imported into Australia, but no trade has occurred to date.

The import requirements for fresh lychee fruit for human consumption can be found at the DAFF website: http://www.daff.gov.au/iconsearch.

DAFF has considered all the pests previously identified in the import risk analysis for longans and lychees from the People's Republic of China and Thailand (DAFF 2004b) and where relevant, taken this information into account in the present assessment for fresh lychee fruit from Taiwan and Vietnam.

Domestic arrangements

The Australian Government is responsible for regulating the movement of 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 or territory government agencies to control interstate movement of plants or their products. It is the importer's responsibility to identify, and to ensure it has complied with all requirements.

1.2.4 Contaminating pests

In addition to the pests of lychees fruit from Taiwan and Vietnam that are assessed in this non-regulated analysis, there are other organisms that may arrive with the imported commodity. These organisms could include pests that have no specific relation to the commodity or the export pathway. DAFF considers these organisms to be contaminating pests that could pose sanitary and phytosanitary risks. These risks are addressed by the procedures indicated in section 5.3.

1.2.5 Consultation

On 15 November 2011, DAFF held a teleconference with representatives of the Australian Lychee Growers Association (ALGA) and Queensland Government Department of Agriculture, Fisheries and Forestry (formerly Queensland Government Department of Employment, Economic Development & Innovation) for an initial consultion on the requests by Taiwan and Vietnam to export fresh lychee fruit to Australia.

On 20 December 2011, DAFF notified stakeholders in Biosecurity Advice 2011/23 of the formal commencement of a non-regulated analysis of existing policy to consider a proposal to import fresh lychee fruit from Taiwan and Vietnam.

On 4 June 2012, DAFF provided a draft pest categorisation table for fresh lychee fruit from Taiwan and Vietnam to all state and territory government departments for their advance consideration of regional pests. Comments on the draft pest categorisation table received from South Australia, Western Australia and Victoria were considered and incorporated in this draft report (PIRSA 2012; DAFWA 2012; DPI Victoria 2012).

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.

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

The final report will be published on the DAFF website and stakeholders informed by a Biosecurity Advice. DAFF 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 process. The conditions proposed in the final report will be the basis of any import permits issued.

2 Method for pest risk analysis

This section sets out the method used for the pest risk analysis (PRA) in this report. DAFF 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, including analysis of environmental risks and living modified organisms* (FAO 2004) 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 2012). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2012).

Quarantine 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, DAFF 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 2012).

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

The PRA was 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.

The pests assessed for their potential to be on the exported commodity (produced using commercial production and packing procedures) are listed in columns 1-3 of Appendix A. 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. Pests that are determined to not be associated with the commodity in column 5 are not considered further in the PRA. 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 column 1 of 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 PRA, 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 DAFF in other risk assessments and for which import policies already exist, a judgement based on the specific circumstances 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 2012).

In this PRA, pest risk assessment was divided into the following interrelated processes:

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, as defined in ISPM 5: *Glossary of phytosanitary terms* (FAO 2012).

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 for the pests considered in this PRA are set out in columns 4-8 in Appendix A. The steps in the categorisation process are considered sequentially, with the assessment terminating with a 'Yes' in column 4 (except for the pests under official control or of regional concern) or the first 'No' in columns 5, 6 or 7. The quarantine pests identified during pest categorisation were carried forward for pest risk assessment and are listed in Table 4.1.

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 2004). 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 Section 3. These practices are taken into consideration by DAFF when estimating the probability of entry.

For the purpose of considering the probability of entry, DAFF 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 considered in the probability of importation 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 (e.g. 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 (e.g. refrigeration) applied to consignments during transport and storage in the country of origin, and during transport to Australia.

Factors considered in the probability of distribution include:

- commercial procedures (e.g. 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 (e.g. 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 2012). In order to estimate the probability of establishment of a pest, reliable biological information (lifecycle, host range, epidemiology, survival, etc.) 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 considered in the probability of establishment in the PRA area 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 2012). 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 considered in the probability of spread 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 the probability of entry, establishment and spread

In its qualitative PRAs, DAFF 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 are given in Table 2.1. The standardised likelihood descriptors provide guidance to the risk analyst and promote consistency between different risk analyses.

Table 2.1 Nomenclature for qualitative likelihoods

Likelihood	Descriptive definition
High	The event would be very likely to occur
Moderate	The event would occur with an even probability
Low	The event would be unlikely to occur
Very low	The event would be very unlikely to occur
Extremely low	The event would be extremely unlikely to occur
Negligible	The event would almost certainly not occur

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 probability of importation is assigned a likelihood of ‘low’ and the probability of distribution is assigned a likelihood of ‘moderate’, then they are combined to give a likelihood of ‘low’ for the probability of entry. The likelihood for the probability of entry is then combined with the likelihood assigned to the probability of establishment (e.g. ‘high’) to give a likelihood for the probability of entry and establishment of ‘low’. The likelihood for the probability of entry and establishment is then combined with the likelihood assigned to the probability of spread (e.g. ‘very low’) to give the overall likelihood for the probability of entry, establishment and spread of ‘very low’. A working example is provided below;

P [importation] x *P* [distribution] = *P* [**entry**] e.g. **low x moderate = low**

P [entry] x *P* [establishment] = *P* [**EE**] e.g. **moderate x moderate = low**

P [**EE**] x [spread] = ***P* [EES]** e.g. **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.

DAFF 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 DAFF’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. Of course, if there are substantial changes in the volume and nature of the trade in specific commodities then DAFF has an obligation to review the risk analysis and, if necessary, provide updated policy advice.

In assessing the volume of trade in this PRA, DAFF 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 2012) and ISPM 11 (FAO 2004).

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, etc.
- 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)[2] using table 2.3[3]. For example, a consequence with a magnitude of ‘significant’ at the ‘district’ level will have a consequence impact score of D.

---

[2] In earlier qualitative IRAs, 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–F has 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.

[3] The decision rules for determining the consequence impact score are presented in a simpler form in Table 2.3 from earlier IRAs, to make the table easier to use. The outcome of the decision rules is the same as the previous table and makes no difference to the final impact score.

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

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

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 above assessments 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 product of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (e.g. 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	**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
		Negligible	**Very low**	**Low**	**Moderate**	**High**	**Extreme**
		Consequences of pest entry, establishment and spread					

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. Australia's ALOP, 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 Australia's ALOP.

2.3 Stage 3: Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve Australia's ALOP, 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 exceeds Australia's ALOP, 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 Australia's ALOP. 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 Australia's ALOP.

ISPM 11 (FAO 2004) 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 probability of entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments – e.g., 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 – e.g., 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 – e.g., pest-free area, pest-free place of production or pest-free production site
- options for other types of pathways – e.g., consider natural spread, measures for human travellers and their baggage, cleaning or disinfestations of contaminated machinery
- options within the importing country – e.g., 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 exceeds Australia's ALOP. These are presented in the 'Pest Risk Management' section of this report.

3 Taiwan and Vietnam’s commercial production practices for lychees

This section provides information on the pre-harvest, harvest and post-harvest commercial production practices in Taiwan and Vietnam for fresh lychee fruit for export. The practices described in this section are considered to be standard for export of lychee production in Taiwan and Vietnam, and DAFF has taken them into consideration when estimating the unrestricted risk of pests that may be associated with the import of this commodity. The export capability of Taiwan and Vietnam is also outlined.

3.1 Assumptions used in estimating unrestricted risk

Taiwan and Vietnam provided DAFF with information on the standard commercial practices adopted in the production of lychees in the different provinces/regions and for all the commercially produced lychee cultivars in Taiwan and Vietnam. This information was complemented with data from other sources and taken into account when estimating the unrestricted risk of pests that may be associated with the import of this commodity.

DAFF visited lychee production areas and packing and treatment facilities in Kaohsiung, Taichung, Nantou and Tainan in Taiwan on 13–15 June 2012, and lychee production areas and packing and storage facilities in the Bac Giang province, Vietnam on 18–20 June 2012. DAFF visited Taiwan and Vietnam to observe and verify information provided by BAPHIQ and PPD, respectively, on lychee cultivation and production, orchard management and the lychee packing process, storage and transport. DAFF's observations and additional information provided during the visit confirmed that the production and processing procedures described in this section are standard commercial production practices for lychees for export.

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

The information for Taiwan and for Vietnam is presented separately.

Taiwan's commercial production practices for lychees

3.2 Production areas

3.2.1 Commercial production areas

The commercial lychee growing regions of Taiwan are distributed across the country. The main commercial production counties or cities are Kaohsiung, Taichung, Nantou, Tainan, Hsinchu, Pingtung, Changhua and Chiayi (Fig. 3.1) (BAPHIQ 2004; 2012a; 2012b). The size of lychee orchards varies from 0.35-5 ha.

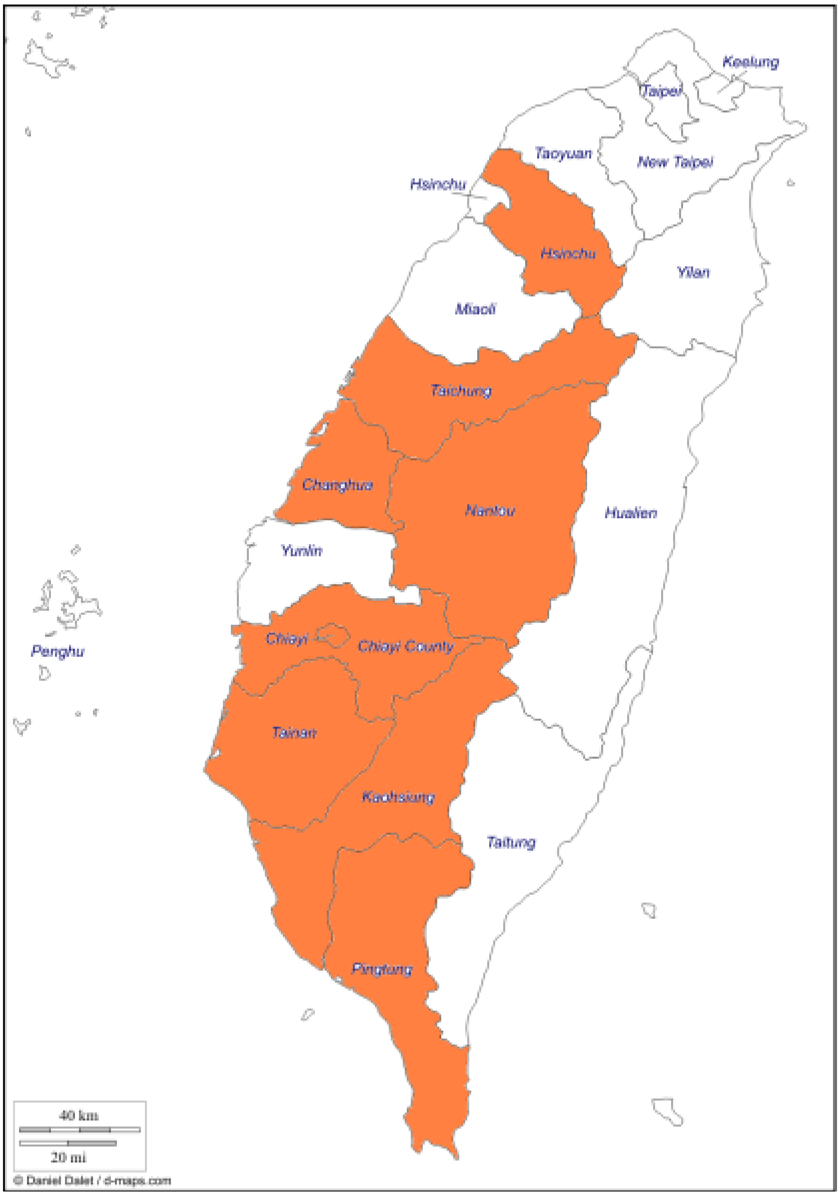

Figure 3.1 Map of Taiwan showing the main lychee producing areas (shaded in orange)

Map source: Oriental Travel (2012). Data source: Kaohsiung, Taichung, Nantou, Tainan, Pingtung, Changhua, Hsinchu and Chiayi (BAPHIQ 2004; 2012a; 2012b)

3.2.2 Climate in production areas

Taiwan is an island located between 25°03'N and 22°00'N. It has a subtropical climate characterised by warm temperatures year-round and heavy rainfall (RDEC 2010). Weather conditions fluctuate during spring and winter and are quite stable during summer and autumn. The wet season falls during March-May and typhoons may occur from May to November (DFAT 2012; Taiwan Tourism Bureau 2012).

The western lychee production areas have hot summers with high rainfall and warm, dry winters. Average temperature is 22–23 °C and annual rainfall is between 1 500 and 2 000 mm. The southwest lychee production areas are hot all year round and have an average temperature of 24–25 °C (BAPHIQ 2012a).

The yearly normal mean temperatures and relative humidity in the lychee production regions of Taiwan are indicated in Figure 3.2.

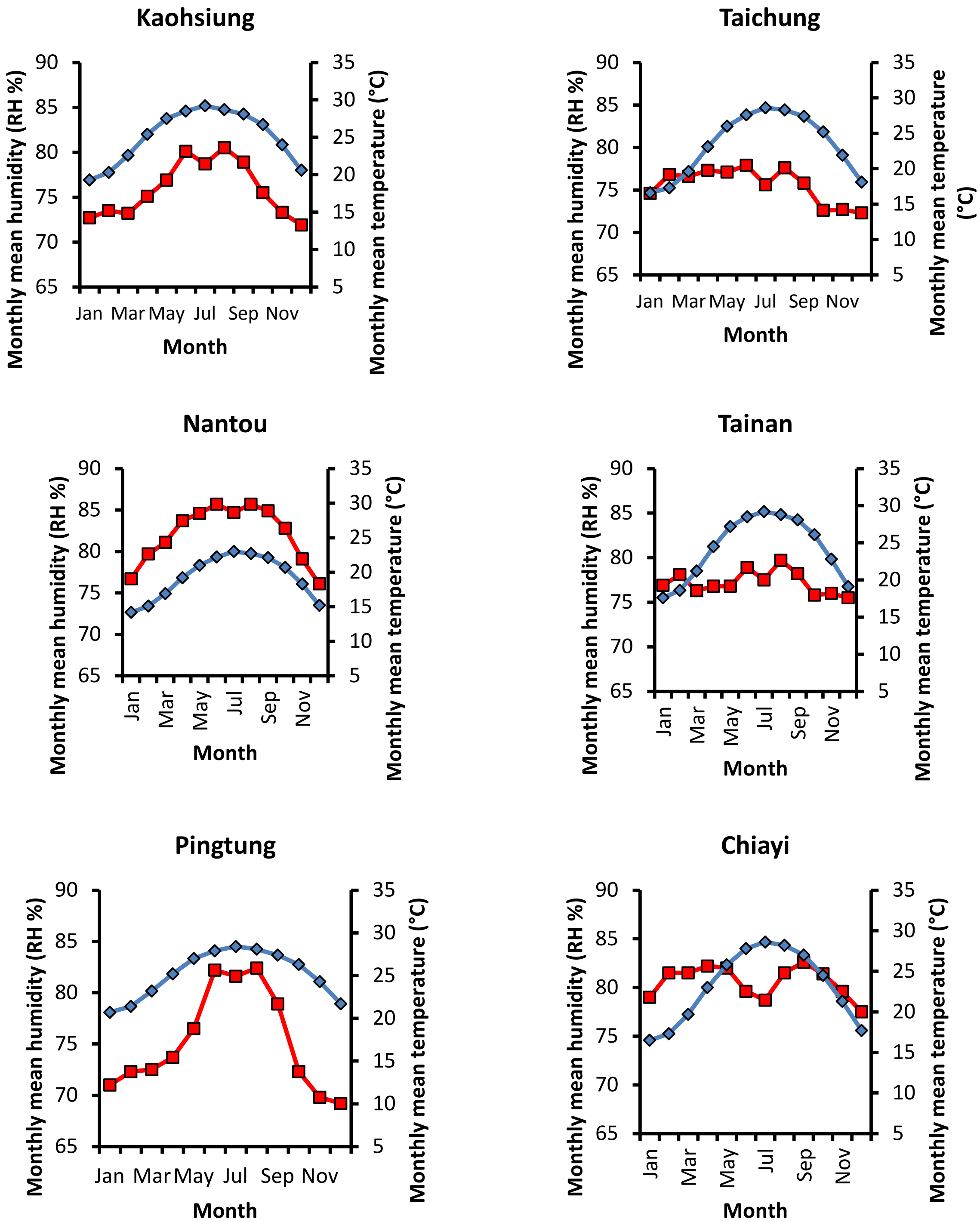

Figure 3.2 **Monthly mean temperature (ºC) (—♦—) and monthly mean relative humidity (%) (—■—) in the Taiwan lychee production areas of Kaohsiung, Taichung, Nantou, Tainan, Pingtung and Chiayi.**

Meteorological data provided by: BAPHIQ (2012b)

3.3 Pre-harvest

3.3.1 Cultivars

Taiwan currently produces 40 cultivars of lychee and 11 of these are economically important. The cultivars Hak Yip, Yu Her Bau and No Mi Tsz are widely grown. Hak Yip about 80% of production because it is adaptive, produces high yields and ripens mid-season (BAPHIQ 2012a). Yu Her Bau accounts for about 12% of production and is an early ripening cultivar, and other cultivars account for less than 10% of production. No Mi Tsz is a late cultivar ripening after Hak Yip. Production of Yu Her Bau and especially No Mi Tsz is more costly and unstable, preventing many farmers from cultivating these cultivars (BAPHIQ 2012a).

Different lychee cultivars suit different cultivation areas. Hak Yip suits central Taiwan and Yu Her Bau is cultivated in Kaohsiung and Pingtung areas of southern Taiwan (BAPHIQ 2012a). Yu Her Bau may be grafted onto Hak Yip in southern Taiwan. No Mi Tsz and Hak Yip are generally not produced in the south (BAPHIQ 2012a).

3.3.2 Cultivation practices

Propagation

In Taiwan, the lychee plant is propagated through layering, a technique to enable a portion of an aerial stem to grow roots while still attached to the parent plant, which is then detached as an independent plant. Layering makes year round planting of lychee possible (BAPHIQ 2004). Grafting is also used, generally with the Yu Her Bau cultivar grafted onto Hak Yip cultivar mother trees.

Planting and cultivation

In Taiwan, lychee trees are usually planted 3–7 m apart (Fig. 3.3).

Figure 3.3 Planting pattern in Taiwan lychee orchards

As lychee is a subtropical fruit tree, high temperatures and humidity during spring and summer are ideal for tree growth, development of fruit and development of fruit-bearing branches for the following season. During autumn and winter, low temperature and dry soil inhibit growth of new branches and induce development of flower buds (BAPHIQ 2012a). Temperature is the principal restricting factor for cultivation. A low-temperature period is necessary for lychee blossom, and the temperature requirement differs among the cultivars: Yu Her Bau only requires 20 ℃ or below for 4 weeks but Hak Yip needs 5–6 weeks under the same temperature condition; No Mi Tsz requires 15 ℃ or below for 6 weeks. Therefore No Mi Tsz is not suitable to grow in southern Taiwan, and Hak Yip is not recommended for planting in southern Taiwan.

Lychee can adapt to sandy or clay soil, but deep and well-drained soil is preferable. Soil pH of 5.0–5.5 is suitable. If soil pH is above 6.0, application of acidic fertiliser is recommended (BAPHIQ 2004; BAPHIQ 2012a).

Pruning

In Taiwan, cutting or breaking off branch tips with each cluster of fruit at harvest is considered to be sufficient to promote new growth for the next crop. However, heavily pruning older trees may be required to increase fruit size and yield for the following few years (BAPHIQ 2004).

Fertilisation

Mature trees require the most fertiliser, which is frequently applied from spring to late summer. Fertiliser is also applied in the orchards post harvest to improve fruit yield the following year (BAPHIQ 2004). Fertiliser may be applied together with irrigation.

Irrigation

Irrigation is required often during the growing period in spring and summer, but standing water in the orchard is avoided. Irrigation is reduced during the flower differentiation stage and the winter season in order to prevent shooting (BAPHIQ 2004). Automatic or semi-automatic spray irrigation is used, sometimes with use of a computer. Irrigation may not be necessary if the area has sufficient rainfall.

3.3.3 Pest management

The main lychee pests in Taiwan include lac insect (*Kerria lacca*), rust mite (*Aceria litchii*), oriental fruit fly (*Bactrocera dorsalis*), litchi fruit borer (*Conopomorpha sinensis*) and downy blossom blight (*Phytophthora litchii*).

Farmers use a combination of orchard sanitation and chemical control to manage pests in Taiwan lychee orchards. Before blossoming, lychee farmers maintain sanitary conditions in orchards and control for pests to lower population density in order to minimise pest damage to fruit later. Chemicals are applied at various spray intervals at particular times of the year to control the main pests (BAPHIQ 2012a). Table 3.1 is a list of chemicals used against pests of lychee trees in Taiwan, their concentrations and the methods of application (BAPHIQ 2012b).

The agricultural research and extension stations are responsible for providing advice on pest management to the lychee growers in their region. Chemical spray calendars are provided to growers for controlling the main pests. Instructions are also provided on fertiliser application, general lychee cultivation including how and what to do at different lychee growing stages. Growers focus on good agricultural practice and sanitation in lychee orchards to prevent pest infestation (BAPHIQ 2012a).

Table 3.1 List of chemicals used for management of main lychee pests in Taiwan (BAPHIQ 2012b).

Abbreviations:

CB – bait concentrate; EC – emulsifiable concentrate; EW – emulsion, oil in water; SC – suspension concentrate;

SP – water soluble powder; WP – wettable powder.

Pest	Chemical	Concentration	Application method
Oriental fruit fly (*Bactrocera dorsalis*)	Trap – DORSALURE (Methyl eugenol + Naled toxic attractant)	95%	Traps deployed long-term, 6–8 per hectare
	Spinosad	0.02% CB	Dilute 8 X. 1 L/hectare
Litchi fruit borer (*Conopomorpha sinensis*)	Phosmet + Lambda-cyhalothrin	42% WP	Dilute 1500 X. 0.5–1.0 kg/hectare Application begins from 10–20 days after blossom drop at 7 day intervals
	Chlorpyrifos + Cypermethrin	50% EC	Dilute 1300 X. 0.5–0.7 kg/hectare Application begins from 20 days after blossom drop at 7 day intervals
	Carbaryl	85% WP	Dilute 850 X. Application begins from 10–20 days after blossom drop, 4–5 times continuously at 7–10 day intervals
	Chlorpyrifos	40.8% EC/EW	Dilute 1000 X. Application begins from 10–20 days after blossom drop, 4–5 times continuously at 7–10 day intervals
	Deltamethrin	2.4% SC	Dilute 1500 X. Application begins from 10–20 days after blossom drop, 4–5 times continuously at 7–10 day intervals
	Fenthion	50% EC	Dilute 1000 X. Application begins from 20 days after blossom drop, 3–4 times continuously at 10 day intervals
	Fenitrothion	50% EC	Dilute 1000 X. Application begins from 20 days after blossom drop, 3–4 times continuously at 10 day intervals
	Carbofuran	40.64% SC	Dilute 800–1200 X. Application begins from 20 days after blossom drop, 3–4 times continuously at 10 day intervals
Downy blight (*Phytophthora litchii*)	Fosetyl-aluminium + Oxine-copper	80% WP	Dilute 800 X. Apply before rainy season or at early stage of infestation at 7 day intervals
	Kasugamycin + Carbendazim	43% WP	Dilute 750 X. Apply before rainy season or at early stage of infestation at 7–10 day intervals
	Dithanon + Copper hydroxide	55% WP	Dilute 500 X. Apply before rainy season or at early stage of infestation at 7 day intervals
	Mancozeb + Cymoxanil	72% WP	Dilute 500 X. Apply before rainy season or at early stage of infestation at 7 day intervals
	Oxine-copper	33.5% SC	Dilute 2000 X. Apply before rainy season or at early stage of infestation at 7 day intervals
	Mancozeb	33% SC	Dilute 600 X. Apply before rainy season or at early stage of infestation at 7 day intervals
	Fermentation metabolites of *Streptomyces candidus* Y21007-2	700 PCU/g SP	Dilute 800 X. 0.8–1.5 kg/hectare. Apply before rainy season 6 times continuously at 7 day intervals

Fruit flies

Fruit flies are not considered serious pests in Taiwan lychee orchards. The damage they cause is usually secondary and females only lay eggs in fruit that have been damaged previously by litchi fruit borer (BAPHIQ 2012a).

Management of oriental fruit fly includes continuous mass male trapping using methyl eugenol with added protein hydrolysate baits (Fig. 3.4). Generally, there are 6–8 traps per hectare. When the population density rises, chemical control will be applied in and around the orchards. Orchard hygiene is also effective (BAPHIQ 2012b).

Figure 3.4 Fruit fly traps used in a Taiwan lychee orchard

Litchi fruit borer

Litchi fruit borer is one of the principal pests in Taiwan lychee orchards. The main management strategy is chemical control. Growers follow the advice of applying recommended chemical sprays 5–6 times at 7–10 day intervals when young fruits begin to develop. Orchard hygiene is important to ensure that litchi fruit borer do not live upon fallen branches, leaves and fruit. Fallen material is removed and burned or treated with chemical to eliminate the source of the borer. Sex pheromone traps are set up in orchards from January to June to monitor the occurrence of litchi fruit borer. Growing lychee and longan in the same or adjacent orchard is not recommended to prevent alternative hosts to sustain the population (BAPHIQ 2012a).

Mealybugs/scales

Mealybugs are not considered serious pests in Taiwan lychee orchards but if mealybugs become a problem in a lychee orchard, pest control spray is applied. Scales are also treated when seen in the orchards. Orchard sanitation is considered important in preventing mealybug and scale infestation (BAPHIQ 2012a; BAPHIQ 2012b).

Downy blossom blight

Downy blossom blight is one of the principal pests in Taiwan lychee orchards. The management focuses on thinning and trimming branches to improve ventilation and sunshine in orchards and lower the humidity. Fallen fruits are removed and burned. Branches near the ground are cut and fruit near the ground are elevated. The orchard floor can be covered by planting grasses or with plastic or non-woven fabric sheets to prevent the pathogen in the soil from contacting fruits nearby (BAPHIQ 2012a).

Chemical control is applied before the rainy season or in the initial stage of disease, and chemicals are sprayed onto the trees as well as the orchard floor. Growers follow the advice of applying regular sprays generally in 7-day intervals (BAPHIQ 2012a).

3.4 Harvesting and handling procedures

Flowering generally takes place between December and February and fruit development generally takes place between February and June. Lychees ripen 80–100 days after flowering in Taiwan. Flavour improves with fruit maturity. The ideal harvest time is when the fruit appears plump and the fruit skin is red to dark red and smooth (BAPHIQ 2004).

Harvest period depends upon the cultivar and the location and each cultivar can have different harvest periods in different growing regions. Five harvest periods can be recognised (Table 3.2) (BAPHIQ 2012a):

Table 3.2 Lychee harvest period in Taiwan

Harvest period	May			June			July			Main cultivar
	Early	Mid	Late	Early	Mid	Late	Early	Mid	Late	
1. Very early harvest		▨	▨							
2. Early harvest				▨						Yu Her Bau
3. Mid harvest					▨					Hak Yip
4. Late harvest						▨				No Mi Tsz
5. Very late harvest							▨	▨	▨	

Harvesting is conducted mostly in the early morning (approx. 5–10 am), and also sometimes in the afternoon. In Taiwan, the lychee trees are usually large and tall. Therefore, a metal fork attached to the tip of a pole about 1.7 metres long is used for lychee harvesting (Fig. 3.5). The metal fork is not for cutting but for pulling the fruit-bearing branches so they break away from larger branches or trunks at the natural breaking point (Fig. 3.6). Individual fruit are detached manually and placed in a ventilated plastic basket (Fig. 3.7). Damaged or deformed fruit are not picked. The baskets are kept in the shade to prevent dehydration. Baskets then are put on a truck and taken to a packing shed (called a ‘goods collection site’) to be sorted and packed that same day (Fig. 3.8).

Figure 3.5 **Detaching branches with fruit from higher regions of the lychee tree in Nantou**

Figure 3.6 **Fruit-bearing branches on the trees (left) and fruit bearing branches broken away from the trees and on the orchard floor (right)**

Figure 3.7 **Lychee are harvested in bunches and individual fruit detached manually and placed in baskets by hand, Nantou**

Figure 3.8 Trucks used to transport harvested fruit from orchard to packing shed, Nantou

3.5 Post-harvest

3.5.1 Sorting and packing

In Taiwan, harvested lychee fruit are generally sorted and packed in two stages.

Initial sorting and packing

Initial sorting and packing can be undertaken in orchards, mobile packing sheds and commonly in permanent packing sheds (goods collection sites). Both mobile and permanent packing sheds are non-enclosed. After the initial sorting, fresh lychee fruit can go directly through to treatment or though a secondary sorting ready for final packing.

Sorting and packing in orchards

Initial sorting can be undertaken in the orchard after harvesting. Harvested lychee fruit are weighed and packed into plastic boxes in the orchards (Fig 3.9).

Figure 3.9 Fruit designated to the USA observed in Nantou were weighed and packed into plastic boxes

Sorting and packing in mobile packing sheds

Mobile packing sheds are sometimes set up by the side of the road with a temporary roof tarpaulin. The sheds are moved around depending upon where fruit are being harvested that day.

Lychee fruit are unloaded from trucks in ventilated plastic baskets. The lychee fruit are fed into the same type of machine used in permanent packing sheds, and the sorting and washing process (Fig. 3.10) is also similar to that used in the permanent packing sheds. Fruit are then placed straight into net bags (Fig. 3.11). Bags are weighed and a label is placed in them to enable trace-back to the grower. The net bags of lychees are then placed into clean crates for transport to a treatment facility.

Figure 3.10 Lychee packing process in mobile packing shed, Nantou

Figure 3.11 Lychees packed into plastic nets first and then in ventilated plastic baskets ready for treatment for export to Japan

Sorting and packing in permanent packing sheds (‘Goods collection site’)

Harvested fresh lychee fruit from the orchard are first put through a machine for sorting and washing in permanent packing sheds. Lychees are fed up the conveyer belt system where a fan removes dirt and debris. The fruit are sorted by size and quality and washed and then dropped into waiting baskets (Fig. 3.12).

Following sorting and packing, lychee fruit are never stored at the packing shed overnight but transported to a dedicated cold storage place, usually associated with a treatment facility. Lychee fruit for export are segregated in the storage from those for domestic distribution.

Figure 3.12 Machine used in permanent packing shed for washing and sorting the lychee fruit, Kaohsiung

Secondary sorting and packing

Secondary sorting and packing takes place in packing sheds associated with treatment facilities, where the lychees are sorted and packed again in preparation for vapour heat treatment (VHT) or for pre-cooling.

A grading machine with electric fans for removing dirt and debris from the fruit is used to re-grade the fruit into different sizes (Fig. 3.13). The fruit is then moved into crates for treatment in the VHT chambers (i.e. Japanese market) or to a pre-cool room to reduce the temperature to 2 °C and then loaded into containers to go through in-transit cold treatment (i.e. the USA market).

Figure 3.13 Secondary sorting and packing of fresh lychee fruit ready for pre-cooling in Nansi, Tainan

Summary for sorting and packing

Fresh lychee fruit packing in Taiwan is undertaken in the orchards or in an open environment, either under a permanent or under a temporary roof. Sorting is done by hand in the orchards or by machine in a packing shed. There appears to be no quarantine security consideration during the field packing process. Quarantine risk is addressed by the treatment process after packing.

Storage

Lychee fruit can be kept in cold storage in a treatment facility and can remain in good condition for up to 2–3 weeks at temperatures of 4–5 °C and 90–95% humidity in plastic wrap, which lessens or prevents browning, dehydration and development of moulds or rots. A lychee storage life of 28–30 days can be obtained by using sealed polyethylene bags (0.05 mm in thickness) with an ethylene absorbent in the bags at temperature of 5 °C.

Fresh lychee fruit destined to undergo cold treatment in transit is stored in a pre-cooling room at 2°C.

3.5.2 Export procedures

Following the pre-export VHT or pre-cooling in preparation for in-transit cold treatment, fruit will undergo phytosanitary inspection and certification by BAPHIQ. Lychees are then loaded into refrigerated containers and shipped to the importing country.

Figure 3.14 summarises the export procedures for lychee from orchard, post-harvest packing shed, transport and storage to the export country, based on information provided by BAPHIQ (2004; 2012a; 2012b) and information gathered on DAFF's verification visit.

3.5.3 Transport

Transport of fresh lychee fruit between packing sheds and treatment facilities within Taiwan are by truck (BAPHIQ 2012a).

Transport of lychees from Taiwan to Australia by sea freight is preferred by Taiwan because it is much cheaper that air freight (BAPHIQ 2012a). Taiwan indicated that currently only 40 ft refrigerated containers are available for this purpose.

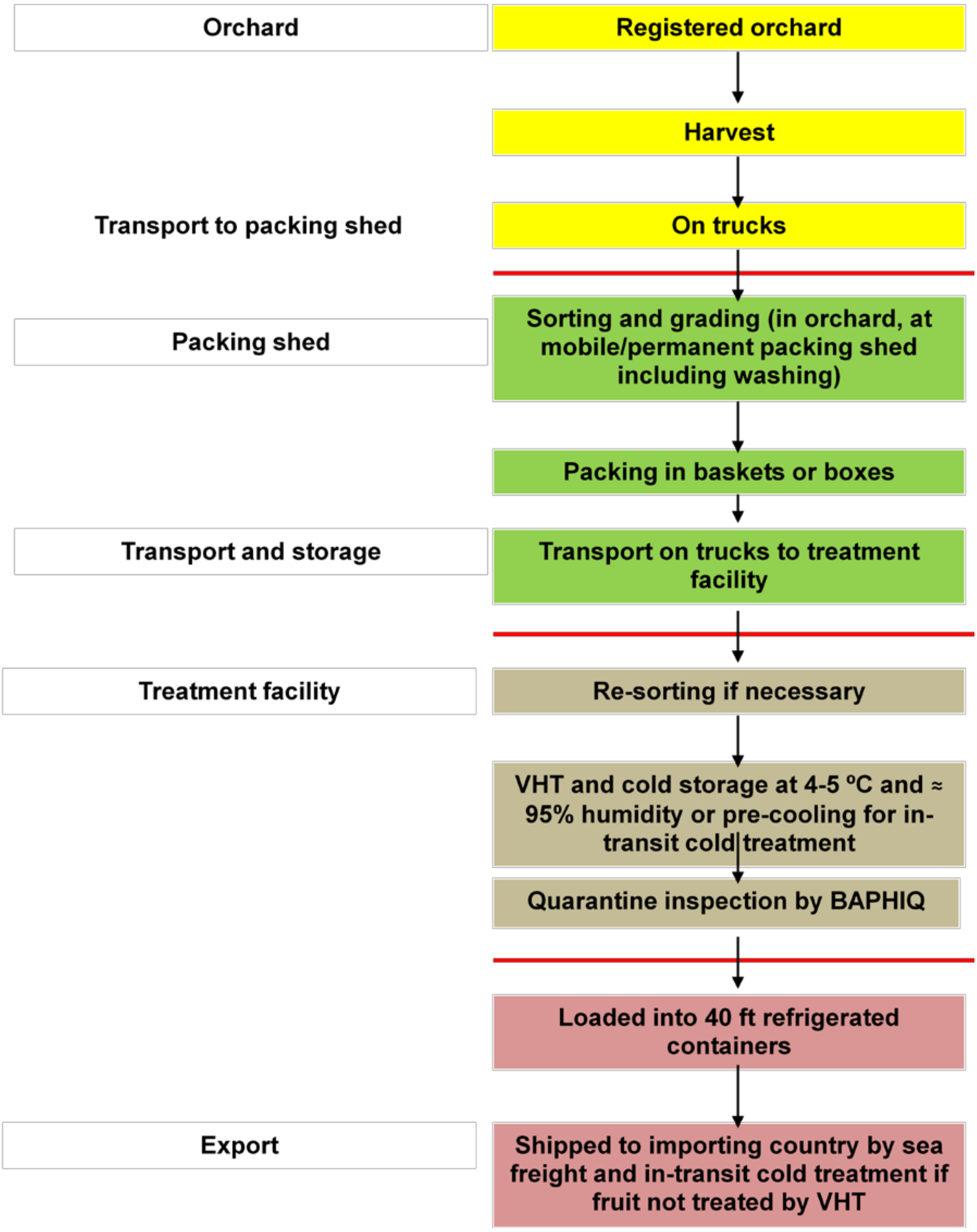

Figure 3.14 Summary of export procedures for fresh lychee fruit grown in Taiwan

3.6 Export capability

3.6.1 Production statistics

In 2010, Taiwan had 11 717 ha of lychee cultivation area and an annual production of 9 440 tonnes (BAPHIQ 2012a).

3.6.2 Export statistics

Taiwan exports fresh lychee fruit to the USA, Japan, Canada, Philippines, Singapore, China, Malaysia, Indonesia and Hong Kong. The USA, Canada and Japan receive the most fruit. Using the Taiwan export volumes from the last five years, the average export volume for lychee fruit per year is about 1 273 tonnes with a value of US$22.40 million (BAPHIQ 2012a).

Table 3.3 shows the volume and value of Taiwan lychee exports to each of its trading partners from 2007–2011 (BAPHIQ 2012a).

Table 3.3 Volume (t) and value (in thousands of US $) of Taiwan lychee fruit exports to each of its trading partners from 2007–2011 (BAPHIQ 2012a)

Country	2007		2008		2009		2010		2011	
	Volume (t)	Value (thousand US $)	Volume (t)	Value (thousand US $)	Volume (t)	Value (thousand US $)	Volume (t)	Value (thousand US $)	Volume (t)	Value (thousand US $)
USA	1434.63	1645.90	623.94	1249.60	707.94	1012.50	674.41	1174.40	580.99	955.70
Japan	102.22	349.40	124.06	550.10	130.96	594.30	132.63	650.80	136.83	788.90
Canada	296.42	341.10	235.73	368.80	499.80	455.50	115.93	219.40	180.09	352.30
Philippines			19.22	20.10			158.19	142.40	118.86	127.30
Singapore	0.86	1.30			0.13	0.10	24.73	19.30	42.64	108.60
China									6.82	16.10
Malaysia					0.24	0.40			11.00	25.60
Indonesia			0.06	0.60					0.30	0.40
Hong Kong	0.14	0.60	0.34	0.60	0.92	0.90	0.35	1.20	0.44	3.30
Spain	2.10	11.20								
Chile			1.50	11.50						
UAE			0.03	0.30						
Total	**1836.37**	**2349.50**	**1004.87**	**2201.60**	**1339.99**	**2063.70**	**1106.24**	**2207.50**	**1077.97**	**2378.20**

Taiwan indicated that the volume of fresh lychee fruit likely to be exported to Australia may reach 600–800 tonnes annually (BAPHIQ 2012a).

Table 3.4 shows the total volume of Taiwan lychee fruit exports per month from May to August from 2007–2011.

Table 3.4 Volume (t) of Taiwan lychee fruit exports each month during the lychee season between 2007 and 2011 (BAPHIQ 2012a)

		Year					
		2007	**2008**	**2009**	**2010**	**2011**	**Total**
Month	**May**		0.03	30.61	11.94	2.03	**44.61**
	June	856.38	40.95	631.01	569.37	272.79	**2430.50**
	July	776.30	879.05	600.40	506.53	689.02	**3451.30**
	August	203.70	84.85	17.96	18.40	113.59	**438.50**
Total per year		**1836.38**	**1004.88**	**1279.98**	**1106.24**	**1077.43**	

3.6.3 Export season

Lychee fruit from Taiwan are usually exported from May to August, with 92.4% of these exports occurring in June and July (Table 3.3). The May to August export season is also predicted for Australia (BAPHIQ 2012a).

Vietnam's commercial production practices for lychees

3.7 Production areas

3.7.1 Commercial production areas

The main commercial lychee growing regions of Vietnam are all located in the northern part of the country. The production provinces are Lao Cai, Lang Son, Tuyen Quang, Thai Nguyen, Hoa Binh, Hanoi, Vinh Phuc, Hai Duong, Hung Yen, Ha Nam, Bac Giang, Ninh Binh, Quang Ninh, Thanh Hoa and Phu Tho (Fig. 3.15) (PPD 2010; 2012a).

Fresh lychee fruit destined for export markets are produced in the Vinh Phuc, Hai Duong, Hung Yen, Bac Giang and Quang Ninh provinces, where there are good production conditions for high yield and quality (PPD 2012a). Some other provinces in the south of Vietnam cultivate lychees; however, the climate is not ideal for growing and the fruit are not popular (PPD 2010).

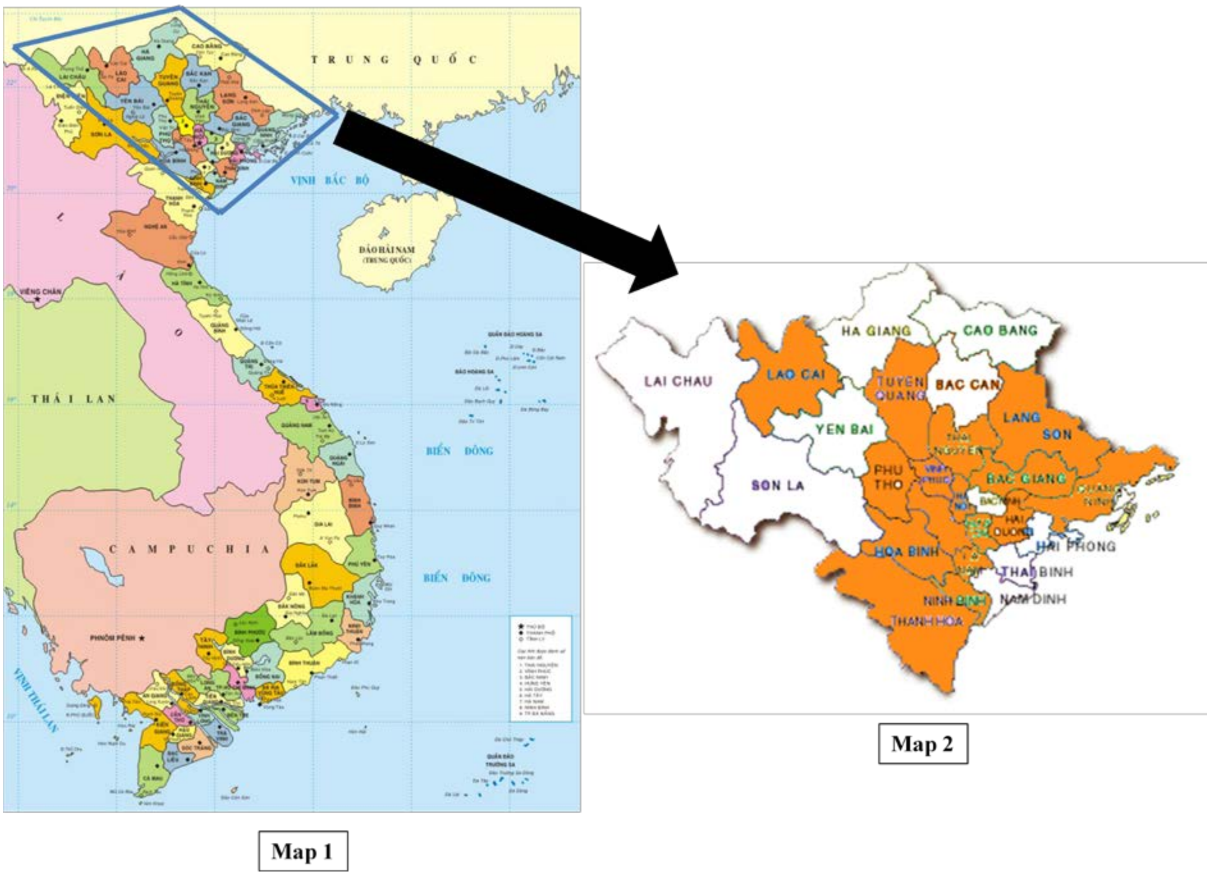

Figure 3.15 **Map 1: Map of Vietnam. Map 2: Northern Vietnam with lychee production provinces shaded in orange (PPD 2010)**

3.7.2 Climate in production areas

Vietnam is located between the latitudes of 23°22'N and 08°25'N and has a tropical monsoon climate. From May to September the south monsoon sets in and the region is characterised by south to southeasterly winds. It is warm and humid with heavy rainfall. From October to April, the north monsoon is dominant with north to northeasterly winds characterising the region (Embassy of Vietnam 2012). There are some cloudy days with occasional light rain. Northern Vietnam is cooler during the north monsoon. There is a transition period between each monsoon season when winds are light and variable (Embassy of Vietnam 2012).

The yearly normal mean temperatures and relative humidities in the lychee growing regions of Vietnam are indicated in Figure 3.16. The regions are very warm from May to September and humid all year around.

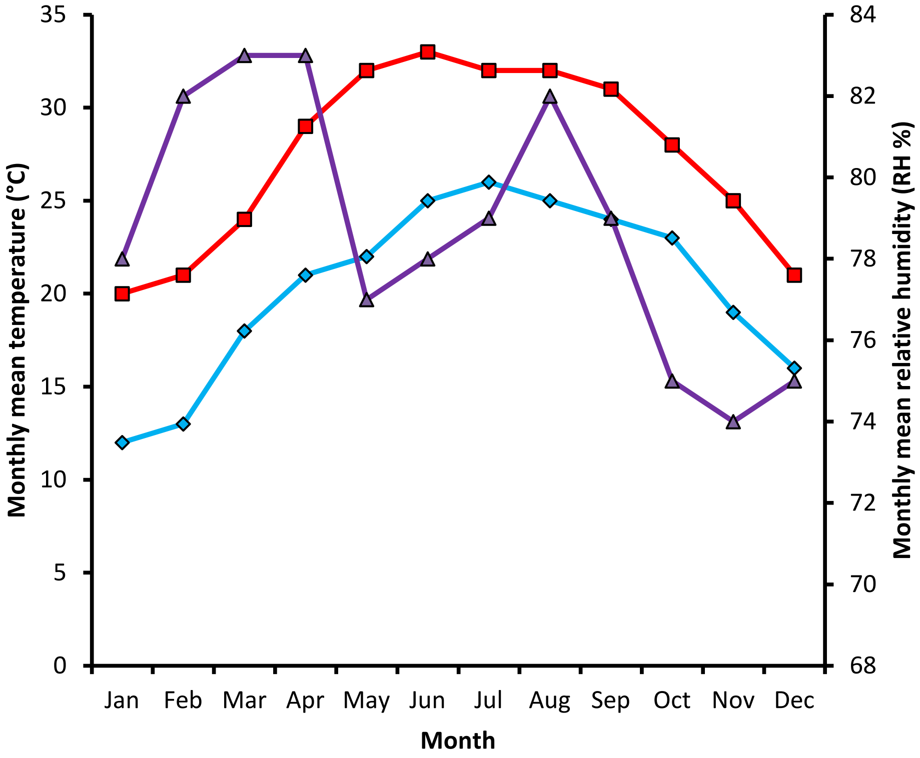

Figure 3.16 Mean maximum (—■—) and minimum (—♦—) temperatures and monthly mean relative humidity (—▲—) in the main lychee producing provinces of Vietnam

Temperature data provided by PPD (2012a); Humidity data (for Hanoi only) provided by BBC Weather (2012)

The average monthly rainfall in the lychee growing regions of Vietnam is shown in Figure 3.17. From May to September the regions experience heavy rainfall, 198 to 345 mm per month. From October to April the rainfall is much lower, 19 to 99 mm per month (PPD 2012a).

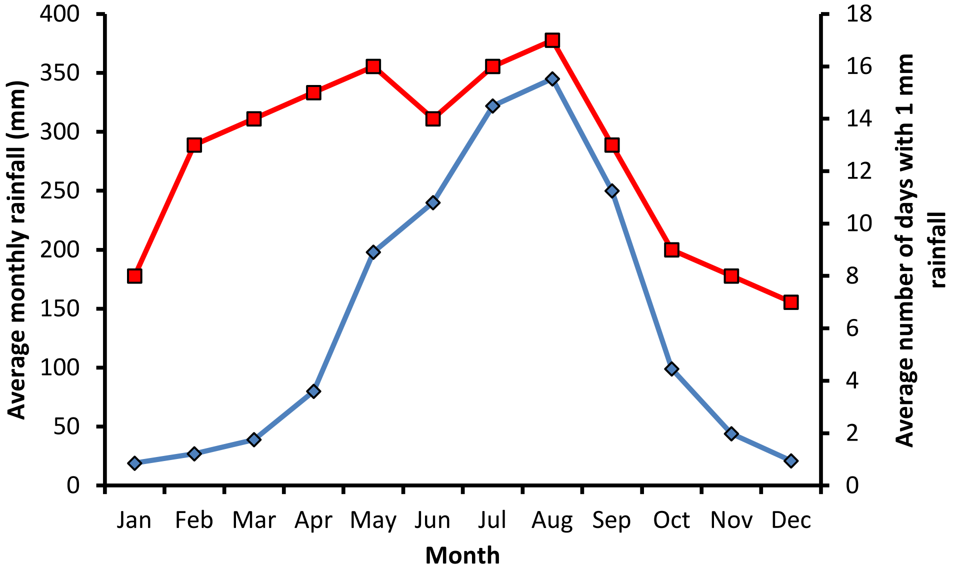

Figure 3.17 Average monthly rainfall (mm) (—■—) and average number of days with 1 mm rainfall (—♦—) in the manin lychee producing provinces of Vietnam

Meteorological data provided by PPD (2012a)

3.8 Pre-harvest

3.8.1 Cultivars

The cultivars of lychee grown in Vietnam including local cultivars have not yet been scientifically classified. Cultivars are mostly named by local people and based on the appearance and morphology of the ripe fruit (including colour). There are fewer cultivars than those named, as the names of cultivars can differ between locations (PPD 2010).

In Vietnam, the cultivar 'Thieu Thanh Ha' accounts for nearly 80% of lychee production (PPD 2010). Vietnam has also developed some commercially promising cultivars of lychee (PPD 2010) and their characteristics are summarised Table 3.5.

Table 3.5 Characteristics of promising lychee cultivars grown in Vietnam (PPD 2010)

Cultivar	Fruit weight (g)	Percentage of fruit that is edible	Colour of peel	Fruit shape	Characteristics of pulp
Hung Long	23.47	73.01	Dark red	Heart-shaped	Sweet, firm and good flavour
Yen Hung	30.10	73.18	Yellowish red	Heart-shaped with flat bottom	Sweet and good flavour
Binh Khe	33.47	71.46	Dark red	Ovate	Sweet and soft
Thieu Thanh Ha	20.70	75.48	Bright red	Spherical	Sweet, firm and good taste and flavour

3.8.2 Cultivation practices

Propagation

In Vietnam, the lychee plant is raised through seed and vegetative means. However, propagation by seed is not common because the plants take 7–12 years to come into fruit-bearing, and do not produce the desired type or quality of fruit (PPD 2012a). Seeds are used to raise seedlings for rootstocks or raising hybrid seedlings. For germination, seed soaked in water for 18–20 hours must be placed horizontally about 1.5 cm below the surface of a well drained soil (PPD 2012a).

Lychees are propagated by cutting and grafting (splice and inarching). Budding is not commonly practised (PPD 2012a).

Planting

In Vietnam, lychee trees are usually planted 4–8 m apart (Fig. 3.18), although they may also be planted up to 10 m apart (PPD 2012b).

Figure 3.18 Vietnam lychee trees planted 4–8 m apart

For rapid establishment and minimal mortality, healthy, ‘true to type’ plants of 6–9 months old with fine roots are selected. After planting, the land should not be allowed to dry completely and hence planting is recommended during early monsoon season (PPD 2012a). Planting can also be done in the spring, if irrigation facilities are available (PPD 2012a).

Lychee trees take about 5–6 years to come to flowering and fruiting. Intercropping with vegetables, pulses and berseem is usual practice. Tillage is used only in the upper soil layers (7–10 cm), as deep tillage is harmful to the lychee plant. Deeper tillage of 10–15 cm is only advised during the inactive growth phase of lychees (PPD 2012a).

Training/Pruning

Training young lychee plants to create a good framework is necessary. Once the desired shape and a strong framework is achieved, pruning is not required, except for removing dead/diseased branches and damaged shoots (PPD 2012a). Pruning occurs when a part of the shoot bearing a fruit cluster is removed during harvesting. Heavy pruning of trees results in profuse vegetative growth and poor fruiting. If trees become old and produce small fruit, pruning heavily can improve the yield and quality of fruit (PPD 2012a).

Manuring and fertilisation

In Vietnam, lychee orchards are fertilised in two different phases of tree development:

1) *Young plants*:
   First fertilisation is at about one month after planting to support establishment and rapid growth of new plants. The dosage is about 20 g of ammonium nitrate + 50 g of phosphate + 20 g of potassium chloride. Fertiliser is applied twice a year for the first these years – once with budding early in the year and once with budding late in the year, when the leaves turn green (PPD 2012a).

2) *Mature plants*:
   Nutrients are required for plant health just after harvest in July and then mid-September. A mixture of 2–2.5 kg of ammonium nitrate + 4–5 kg of phosphate + 2 kg potassium chloride is used (PPD 2012a).

Manuring practice is similar to that of other fruit crops. Plants deficient in nitrogen, phosphorus and potassium can flower but do not produce fruit, and plants deficient in magnesium do not flower (PPD 2012a).

Irrigation

Irrigation is commonly carried out according to the VietGAP orchard management program. Irrigation may be carried out manually or by above/below ground piping.

3.8.3 Pest management

The main pests of lychees concerning growers in the main lychee growing areas such as Bac Giang province are litchi fruit borer (*Conopomorpha* sp.), downy blossom blight (*Phytophthora litchii*) and anthracnose (*Colletotrichum gloeosporioides*).

Orchards are kept in a clean, sanitary condition to prevent pest and disease establishment. Integrated Pest Management (IPM) programs are used to reduce pesticide use (PPD 2012a).

Growers follow a pest management booklet provided by the Ministry of Agriculture and Rural Development (MARD) to control these pests. Growers may also spray for other pests when they are seen on lychee plants. Table 3.6 lists the chemicals used on common pests in Bac Giang lychee orchards (PPD 2012b).

To control downy blossom blight, growers use biochemical sprays prior to flowering, or chemical sprays 1–2 times on young fruit.

Growers monitor the populations of litchi fruit borer and spray according to the instructions in the pest management booklet. Pesticides are used in the early season for litchi fruit borer larvae living external to fruit. Crops are sparayed at the end of March, April and May and 15 days prior to harvest (PPD 2012b). Due to this pest having many life stages, growers can predict when to treat the lychee crops. Growers also reduce litchi fruit borer populations by destroying infested or fallen fruits (PPD 2012b). Protein baits made from beer by-product may be used to trap litchi fruit borer in orchards.

Mealybugs and scales occur in these orchards; however, they are not significant pests. Growers follow the MARD pest management booklet for controlling mealybugs and scales. These pests are sprayed for according to population density, and $Ca(OH)_2$ can be used on the ground to control these pests in December.

Fruit flies are not a serious problem in lychee orchards in Vietnam. Pheremones may be used to forecast and monitor the presence of fruit flies, so that growers know when to control for them.

Prior to each lychee season, plant protection officers from MARD conduct IPM training for growers on managing lychee pests and instruct growers on the use of pesticides and timing of application. These local plant protection officers as well as local quarantine officers monitor the occurrence of the pests in the orchards and advise growers of any pest incursions and necessary management techniques (e.g. use of chemicals). MARD officers also carry out unscheduled surveys and checks of orchards and look for pests of lychees. There is a lychee production television channel in the Bac Giang province that growers can use as guidance for the cultivation of lychees and control of pests.

Table 3.6 List of chemicals and their active ingredients used for management of main lychee pests in Vietnam (PPD 2012b)

Abbreviations:

DP – dispersible concentrate; EC – emulsifiable concentrate; FL – flowable liquid; SC – suspension concentrate; WP – wettable powder.

Pest	Chemical	Active ingredients
Aphis gosypii *Buzura suppressaria* *Chloropulrinavia psidii* *Conopomorpha sinensis* *Ricana pulverosula* *Toxoptera* sp.	Abasuper 1.8 EC	Abamectin
	Abatimec 1.8 EC	
	Abatin 1.8 EC	
	Brightin 4.0 EC	
	Phumai 1.8 EC	
	Shertin 5.0 EC	
	Shepatin 18 EC, 36 EC	Abamectin + Alphacypemethrin
	Secsaigon 10 EC, 5 EC	Cypemethrin
	Pegasus 500 EC	Diafenthiaron
Colletotrichum gloeosporioides	Carbenvin 50 SC	Carbendazim
	Carben 50 WP	
	Nanage 5 WP	Imibenconazole
Colletotrichum gloeosporioides *Phythophthora litchii*	Bavistin 50 FL	Carbendazim
	Antracol 70 WP	Propineb
Phythophthora litchii	Arggeen 75 WP	Chlorothalonil
	Dacolin 75 WP	
	Champion 57.6 DP	Copperhydroxit
	Coc 85 WP	Copperoxychloride
	Dong Oxiclorua 30 WP	
	Supercook 85 WP	
	Dithane N-45 WP	Mancozeb
	Dithan 80 WP	
	Zidozeb 72 WP	
	Zomil 72 WP	
	Ridomil gol 68 WP	
	Anconeb 70 WP	
	Topsin 70 WP	Thioplanatemethye

Seventeen units (independent of government) are nominated by MARD to issue VietGAP certification for the whole of Vietnam. Prior to approving certification, officers from the units check the orchards and the information provided by growers. These 17 units are responsible for checking that VietGAP is being implemented in these orchards. If a lychee orchard is VietGAP certified, then the orchard must keep a diary of chemicals used for pest control.

In Vietnam, weeds are controlled mainly by hand weeding or hoeing which is very laborious and expensive. Applying pre-emergence herbicides diuron or atrazine at 5 kg/ha at one month intervals keeps weeds under control. Use of black polythene mulch also controls weeds more effectively than organic mulch (PPD 2012a).

3.9 Harvesting and handling procedures

In northern Vietnam, flowering takes place between December and February and fruiting takes place between February and March.

The length of time required for fruit to mature varies with genotype and environment. Generally fruit mature 50–60 days after fruit set. Colour of the fruit can indicate maturity but this differs between cultivars (PPD 2012a). Maturity of fruit is also determined by the shape of tubercles. Upon ripening they become flattened and the epicarp becomes smooth. Generally fruit turn deep red when fully ripe. Fruit harvested at this stage are of high quality (PPD 2012a).

Harvest takes place between May and July. The preferred lychee cultivar in Vietnam is harvested from mid-June and harvest lasts about one month (PPD 2012a). Harvesting is conducted in the early morning, and late afternoon on cool, dry days (PPD 2010). Harvest may also be undertaken all day, however this is less common.

In Vietnam for current markets, fresh lychee fruit are not harvested individually to avoid skin rupturing at the stem and causing rapid rotting of the fruit (PPD 2012a). Lychee fruit are harvested in bunches by hand with a portion of the branch and a few leaves still attached (Fig. 3.19). This prolongs the storage life of fruit (PPD 2012a). Harvested fruit are initially graded/sorted and weighed in the orchards, and then placed in open wicker baskets and placed on motorbikes to be taken to packing sheds to be packed as quickly as possible (Fig. 3.20).

Figure 3.19 Wicker baskets used in the orchard to hold harvested fruit and knife used to cut branches from the lychee tree

Figure 3.20 **Lychee fruit weighed in the orchard and placed on the back of a motorbike for transport to packing sheds**

The fruit for domestic sale is harvested at the fully ripe stage, whereas fruit for export is harvested when skin starts turning reddish (PPD 2012a). If sale of the packed fruit is delayed, it is kept in cold storage (PPD 2012a).

Lychees are grown mainly for fresh consumption in Vietnam. Fruit rejected for fresh consumption or any extra fruit is sent for drying. As lychees are highly perishable fruit, canning and preserving lychees for pulp, jelly and juice is ideal for utilising surplus produce (PPD 2012a).

3.10 Post-harvest

3.10.1 Sorting and packing

Sorting

Lychee fruit are usually graded/sorted in the orchard after harvest, and then graded and sorted once again in packing sheds for removing damaged, sun-burned and cracked fruit (PPD 2012a).

Cooling, packing and storage

Currently in Vietnam, non-enclosed packing sheds by the side of the road are set up to sort and pack fruit (Fig. 3.21). Fruit is kept in bundles in large piles. Bundles are placed in baskets and weighed. Fruit are then dunked in iced water for washing and placed in plastic lined styrofoam boxes. The boxes contain ice to keep the fruit fresh and cool. A spongy material layer is placed on top of the packed fruit and covered with more ice. The box is then lidded, taped up and placed on a cold container truck for transport for direct export or to treatment facilities if that is required by the importing country.

Figure 3.21 **Packing of lychee fruit from large piles into boxes for transport. Fruit is moved through weighing and washing process and packed into sealed styrofoam boxes**

Where cold storage facilities are available, lychee fruit can be stored at 4–5°C and 90–95% humidity to maintain quality (PPD 2012a). Cold storage retains colour and taste and minimises fruit weight loss. Lychee fruit can be kept in good condition in storage for 3–4 weeks (PPD 2012a).

Vietnam has also indicated that the type of packing boxes/materials used can be altered for the requirements of the importing country.

3.10.2 Export procedures

Following the pre-export treatments by VHT, irradiation (option most likely used by Vietnam), or pre-cooling, fresh lychee fruit will undergo quarantine inspection by Vietnam's quarantine authority and then be loaded into cargo aircrafts or refrigerated containers for transportation to the importing country.

Figure 3.22 summarises the export procedures for Vietnam lychee from orchard, post-harvest packing shed, transport and storage to the export country, based on information provided by PPD (2012a) and information gathered on DAFF's verification visit.

3.10.3 Transport

Fresh lychee fruit is transported by truck under cold storage conditions at 4–5°C and 90–95% humidity from northern Vietnam where the production areas are located to the VHT or irradiation treatment facilities located in the south (Ho Chi Minh City) (PPD 2012a). PPD has indicated that fresh lychee fruit treated using irradiation will be transported to Australia using air freight (PPD 2012a).

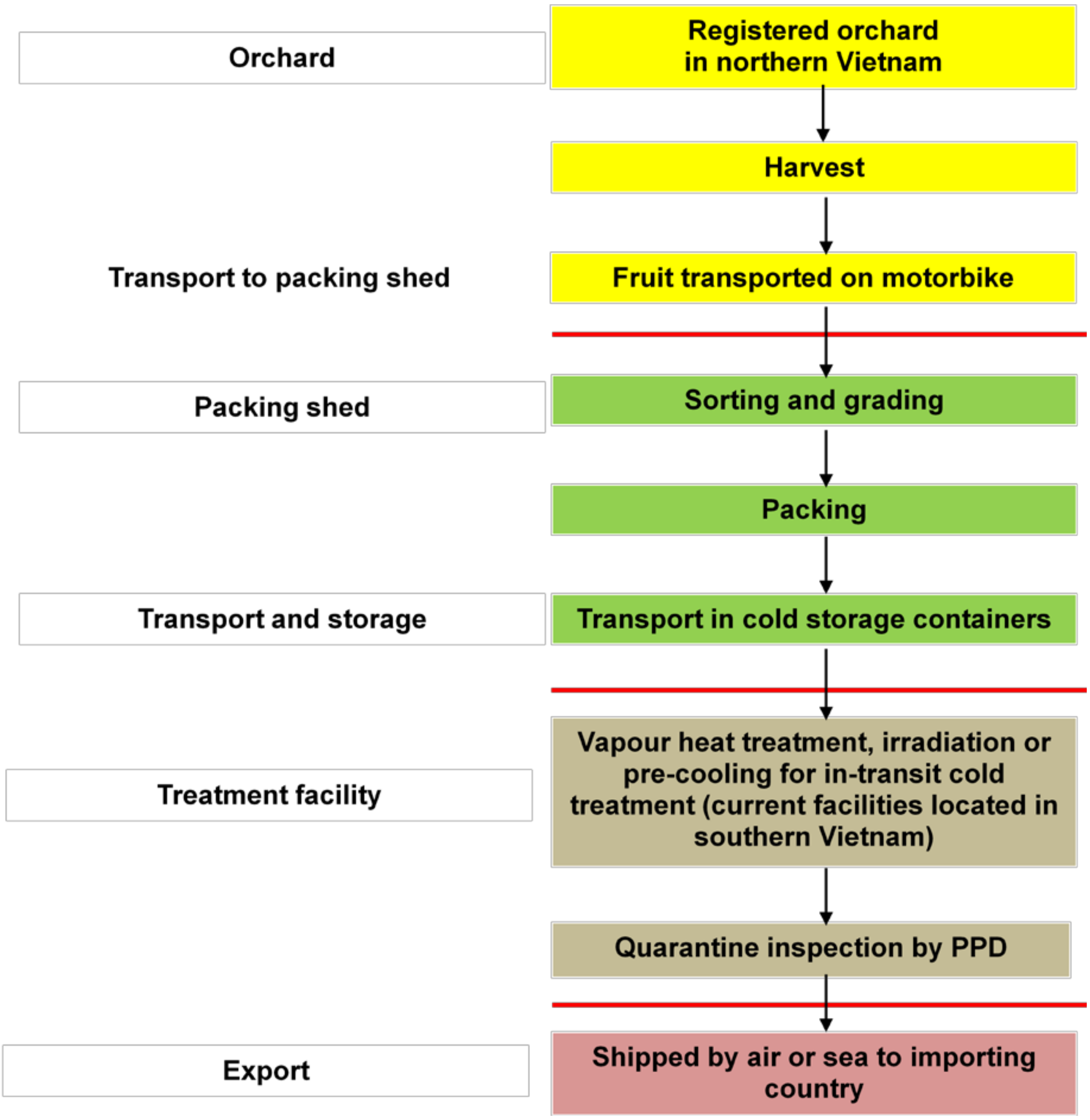

Figure 3.22 Summary of export procedures for Vietnamese lychees

3.11 Export capability

3.11.1 Production statistics

Vietnam has over 60 000 ha of lychee production areas. In 2011 the total yield was about 200 000 tonnes (PPD 2012a). Table 3.7 shows the amount of lychee fruit produced in Vietnam from 2004 to 2011 (PPD 2012a).

Table 3.7 Lychee fruit production (t) in Vietnam between 2004 and 2011 (PPD 2012a)

Year	Production (t)
2004	120 000
2005	140 000
2006	130 000
2007	160 000
2008	140 000
2009	140 000
2010	120 000
2011	200 000

3.11.2 Export statistics

Currently Vietnam exports lychee fruit to China, Russia, the European Union and Malaysia. China is Vietnam’s largest market, with approximately 70 000 tonnes of lychee fruit exported in 2011. Other export markets receive 500–1 000 tonnes of lychee in total annually (PPD 2012a).

Vietnam has indicated a capacity to export around 200 tonnes of lychees to Australia annually for the first five years (PPD 2012a).

3.11.3 Export season

Lychee fruit from northern Vietnam are usually harvested between May and July each year, which is also the potential export season.

4 Pest risk assessments for quarantine pests

Quarantine pests associated with fresh lychee fruit from Taiwan and Vietnam are identified in the pest categorisation process (Appendix A). This section assesses the probability of the entry, establishment and spread of these pests and the likelihood of associated potential economic, including environmental, consequences.

Pest categorisation identified 16 quarantine pests associated with fresh lychee fruit from Taiwan and/or Vietnam. Of these, 13 pests are of national concern and three are of regional concern. Table 4.1 identifies these quarantine pests, and full details of the pest categorisation are given in Appendix A. Additional quarantine pest data are given in Appendix B. Assessments of risks associated with these pests are presented in this section. Pests are listed or grouped according to their taxonomic classification, consistent with Appendix A and Appendix B.

Pest risk assessments were completed to determine whether the risk posed by each pest exceeds Australia's ALOP and thus whether phytosanitary measures are required to manage the risk.

Pest risk assessments already exist for some of the pests considered here as they have been assessed previously by DAFF. For these pests, the likelihood of entry (importation and/or distribution) is re-assessed due to the differences in the commodity and/or country assessed. This type of assessment is reflected in the introduction and layout of the risk assessments that follow. In this report, the superscript 'EP' (existing policy) is used for pests that have previously been assessed and where a policy already exists.

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. These organisms are identified with a superscript, such as 'WA' (Western Australia), for the state for which the regional pest status is considered.

Fresh lychee fruit harvested, packed, stored and transported for export to Australia may need to travel variable distances to ports. Depending on the port of departure and arrival it could take up to three weeks for general sea freight from Taiwan and/or Vietnam to Australia. Fresh lychee fruit could also potentially be air-freighted from Taiwan and/or Vietnam to Australia within a few days after harvest. While the unrestricted risk assessments undertaken in this risk analysis do not impose any mandatory measures during storage and transport, common commercial practices may impact on the survival of some pests. If these conditions are applied to all consignments for a minimum period of time, then those conditions can be considered as part of the unrestricted risk assessment.

Table 4.1 Quarantine pests for fresh lychee fruit from Taiwan and Vietnam

Pest	**Common name**
Fruit flies (Diptera: Drosophilidae)	
Bactrocera cucurbitae Coquillet EP	Melon fruit fly
Bactrocera dorsalis (Hendel) EP	Oriental fruit fly
Armoured scales [Hemiptera: Diaspididae]	
Ischnaspis longirostris (Signoret) EP, TW, WA	Black thread scale
Parlatoria cinerea (Danne & Hadden) EP	Tropical grey chaff scale
Selenaspidus articulatus (Morgan) EP, TW, WA	Rufous scale
Mealybugs (Hemiptera: Pseudococcidae)	
Dysmicoccus lepelleyi (Betrem) EP	Lepelleyi mealybug
Paracoccus interceptus Lit EP	Intercepted mealybug
Planococcus lilacinus (Cockerell) EP	Coffee mealybug
Planococcus litchi Cox EP, VN	Litchi mealybug
Planococcus minor (Maskell) EP, WA	Passionvine mealybug
Pseudococcus cryptus Hempel EP	Citriculus mealybug
Pseudococcus jackbeardsleyi Gimpel & Miller EP	Jack Beardsley mealybug
Litchi fruit borers [Lepidoptera: Gracillariidae]	
Conopomorpha sinensis Bradley EP	Litchi fruit borer
Summer fruit tortrix moth (Lepidoptera: Tortricidae)	
Adoxophyes orana (Fischer von Röeslerstamm) EP, TW	Summer fruit tortrix moth
Downy blight [Peronosporales: Peronosporaceae]	
Phytophthora litchii (CC Chen ex WH Ko, HS Chang, HJ Su, CC Chen & LS Leu) Voglmayr, Göker, Riethm. & Oberw EP	Downy blight
Phytophthora sp. VN	

EP: Species has been assessed previously and import policy already exists.
TW: Species has been reported in Taiwan but not in Vietnam.
VN: Species has been reported in Vietnam but not in Taiwan.
WA. Regional pest for the state of Western Australia.

4.1 Fruit flies [Diptera: Tephritidae]

These species have been assessed previously and import policy already exists as follows:

Bactrocera cucurbitae **EP**	Mangoes from the Philippines (AQIS 1999b) and Taiwan (Biosecurity Australia 2006b); longans and lychees from China and Thailand (DAFF 2004b).
Bactrocera dorsalis **EP**	Pears from China (AQIS 1998b; Biosecurity Australia 2003; Biosecurity Australia 2005); longans and lychees from China and Thailand (DAFF 2004b), mangosteens from Thailand (DAFF 2004c), mangoes from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a), apples and table grapes from China (Biosecurity Australia 2010; Biosecurity Australia 2011).

Bactrocera cucurbitae, melon fly and *B. dorsalis*, Oriental fruit fly, belong to the fruit fly family Tephritidae which is a group considered to be among the most damaging pests of horticultural crops (White and Elson-Harris 1992). Both species are serious pests of a wide range of commercial fruit crops in parts of Asia (White and Elson-Harris 1992).

B. cucurbitae and *B. dorsalis* have four life stages: egg, larva, pupa and adult. Adults are predominantly black, or black and yellow. Eggs are laid below the skin of the host fruit. Hatched larvae feed within the fruit and third instar larva are 7.5–10.0 mm long and 1.5–2.0 mm wide. Pupation occurs in the soil under the host plant (CABI 2012). It can produce several generations a year, depending on the temperature (CABI 2012).

The risk scenario of concern for *B. cucurbitae* and *B. dorsalis* is the presence of eggs and developing larvae within imported fresh lychee fruit.

The assessment of *B. cucurbitae* and *B. dorsalis* presented here builds on the previous policies listed above.

The probability of importation for both *B. cucurbitae* and *B. dorsalis* was rated as ‘high’ in the assessments for longans and lychee from China and Thailand (DAFF 2004b). However, differences in horticultural practices, climatic conditions and the prevalence of *B. cucurbitae* and *B. dorsalis* between previous export areas (China, Thailand and India) and current areas (Taiwan and Vietnam) make it necessary to reassess the likelihood that *B. cucurbitae* and *B. dorsalis* will be imported into Australia with fresh lychee fruit from Taiwan and Vietnam.

The probability of distribution of *B. cucurbitae* and *B. dorsalis* in Australia will be the same for lychees from China and Thailand (DAFF 2004c) and their probability of establishment and of spread in Australia, and the consequences they may cause will be comparable for any commodity in which the species are imported into Australia, as these probabilities relate specifically to events that occur in Australia and are largely independent of the importation pathway. Accordingly, there is no need to reassess these components and previous assessments are adopted for the species.

4.1.1 Reassessment of probability of importation

The likelihood that *B. cucurbitae* and *B. dorsalis* will arrive in Australia with the importation of lychees from Taiwan and Vietnam is: **HIGH**.

Supporting information for this assessment is provided below:

- Both *B. cucurbitae* and *B. dorsalis* are reported in Taiwan (Wen 1985) and Vietnam (PPD 2012a).
- *Bactrocera cucurbitae* is reported in lychee orchards (Wen 1985; Waite and Hwang 2002), although PPD (2012a) claims that lychee is not a host. BAPHIQ (2012a) indicates that *B. cucurbitae* is a major pest of cucurbits in Taiwan but there has been no record of its damage to lychee fruit, although lychee orchards are potential habitats of adults.
- There are many reports of lychees as host of *B. dorsalis* (Waite and Hwang 2002; CABI 2012).
- Female fruit flies lay their eggs through the skin of lychee fruit. Fruit flies prefer to lay their eggs in mature fruit, and several eggs may be laid below the skin of a single fruit. Although both fruit fly species are capable of ovipositing through the skin of lychees, some cultivars have a thicker skin that prevents successful oviposition (Waite and Hwang 2002).
- Damage by *B. dorsalis* on lychee fruit is considered as secondary and oviposition can only occur on fruit previously injured by litchi fruit borer (*Conopomorpha sinensis*) (BAPHIQ 2012a). Such fruit are unlikely to be harvested and packed for export.
- Once in the fruit, the larvae can survive in picked fruit and therefore are likely be present in fruit that is packed for export. As fruit fly eggs are laid internally, infested fruit are not likely to be detected during sorting, packing and inspection procedures.
- It is likely that fruit fly larvae would survive fresh lychee fruit storage and transportation at 4-5°C. Adult flies cannot survive more than a few days without feeding.

The ability of *B. cucurbitae* and *B. dorsalis* to feed, develop and reproduce on lychee fruit and their internal habitat, supports a likelihood estimate for importation of ‘high’.

4.1.2 Probability of distribution, of establishment and of spread

The probability of distribution, of establishment and of spread for *B. cucurbitae* and *B. dorsalis* will be the same as those assessed for longans and lychees from China and Thailand (DAFF 2004b).The likelihood estimates from the previous assessments are presented below:

Probability of distribution:	**HIGH**
Probability of establishment:	**HIGH**
Probability of spread:	**HIGH**

4.1.3 Overall probability of entry, establishment and spread

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

The likelihood that *B. cucurbitae* and *B. dorsalis* will enter Australia as a result of trade in lychees from Taiwan and Vietnam, be distributed in a viable state to a susceptible host, establish in that area and subsequently spread within Australia: **HIGH**.

4.1.4 Consequences

The consequences of the establishment in Australia of *B. cucurbitae* and *B. dorsalis* have been estimated previously for longans and lychees from China and Thailand (DAFF 2004b) and for mangoes from Taiwan (Biosecurity Australia 2006b), and of *B. dorsalis* for apples and table grapes from China (Biosecurity Australia 2010; Biosecurity Australia 2011). The estimate of impact scores is provided below.

Plant life or health	**E**
Any other aspects of the environment	**C**
Eradication, control, etc.	**F**
Domestic trade	**E**
International trade	**E**
Environment	**D**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to a single criterion has an impact of '**E**', the overall consequences are estimated to be **HIGH**.

4.1.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *B. cucurbitae* and *B. dorsalis*	
Overall probability of entry, establishment and spread	High
Consequences	High
Unrestricted risk	High

As indicated, the unrestricted risk estimate for *B. cucurbitae* and *B. dorsalis* of 'high' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.2 Armoured scales [Hemiptera: Diaspididae]

These species have been assessed previously and import policy already exists as follows:

Ischnaspis longirostris $^{\mathrm{EP,\ TW,\ WA}}$	Mangosteens from Indonesia (DAFF 2012).
Parlatoria cinerea $^{\mathrm{EP}}$	Tahitian limes from New Caledonia (Biosecurity Australia 2006a).
Selenaspidus articulatus $^{\mathrm{EP,\ TW,\ WA}}$	Bananas from the Philippines (Biosecurity Australia 2008b).

Ischnaspis longirostris and *Selenaspidus articulatus* are not present in Western Australia and are pests of regional quarantine concern for that state.

The biology and taxonomy of these three species are considered sufficiently similar to justify combining them into a single assessment. In this assessment, the term ‘armoured scales’ is used to refer to these three species unless otherwise specified.

Ischnaspis longirostris, black thread scale, *P. cinerea,* tropical grey chaff scale and *S. articulates,* West Indian red scale are members of the family Diaspididae, which produce a hard, fibrous, wax-like covering that attaches the scale to the host plant (Carver *et al.* 1991). Unlike the soft scales, armoured scales do not produce honeydew-like secretions that commonly cause sooty mould to develop (Beardsley Jr and Gonzalez 1975).

These armoured scales are near-cosmopolitan and occur throughout the tropics, and the subtropics of the world. They are also common in greenhouses of the cold to temperate climates of the northern hemisphere (Ben-Dov *et al.* 2012).

Ischnaspis longirostris is a highly polyphagous species that has been recorded on hosts from 70 genera in 35 families, including lychees (Ben-Dov *et al.* 2012). It is an economic pest of citrus, coconut, coffee, mango, avocado, banana, palms and greenhouse plants (CABI 2012; Ben-Dov *et al.* 2012).

Parlatoria cinerea is a highly polyphagous species that has been recorded on many host plants include: soursop; citrus; crabapple and wine grape (Ben-Dov *et al.* 2012).

Selenaspidus articulatus is also a highly polyphagous species that has been recorded from 122 wild and commercial host species belonging to 48 plant families (Ben-Dov *et al.* 2012). This species is an important pest of commercial plants, particularly citrus, coffee and olives (Watson 2005). Other host plants include custard apple, carambola, tea, papaya, coconut palm, mango, banana, passionfruit, avocado and grapes (Ben-Dov *et al.* 2012).

Armoured scales affect their hosts by removing sap, as well as by injecting toxic saliva during feeding (Kosztarab 1990; McClure 1990a). The feeding process results in cell death, deformation of plant parts and the formation of galls and pits, as well as increased susceptibility to other destructive agents such as frosts, disease and other pests (Kosztarab 1990; McClure 1990a). High populations of scales can cause the death of host plants (Beardsley Jr and Gonzalez 1975).

In general, scale nymphs (crawlers) settle and feed on branches, leaves and fruit of the host plant, becoming immobile as they develop into late instar nymphs (Beardsley Jr and Gonzalez 1975; Koteja 1990b). The female life stages include an adult, egg and nymph, while the male has adult, egg, nymph, pre-pupa and pupa stages (Beardsley Jr and Gonzalez 1975; Koteja

1990b). The female reaches sexual maturity undergoing slight metamorphosis of the internal and external organs (Koteja 1990b). The adult female resembles a slightly larger nymph, remaining legless and immobile on the host plant (Takagi 1990). This contrasts with the male scale, which has a pupal stage, emerging as a winged adult form (Koteja 1990b). The mature adult female is approximately 1.0–1.5 mm in length (Takagi 1990). The mature adult male is seldom seen and is rarely more than 1.0 mm in length (Giliomee 1990).

The adult males of armoured scales only live for 1–3 days (Koteja 1990b). They do not feed and their primary purpose is to locate a female and mate (Koteja 1990b). The adult female can reproduce with or without a male scale (Beardsley Jr and Gonzalez 1975) and will continuously produce offspring for several weeks until death (Koteja 1990a). Female scales will lay 1–10 eggs daily, with some scale species also able to give birth to live young (Beardsley Jr and Gonzalez 1975; Koteja 1990a). The number of offspring produced by a female armoured scale is relatively low, generally around 50–150 (Koteja 1990a). The number of generations per year varies depending on the species and climatic conditions (McClure 1990b) with either eggs, first instar nymphs or adult females overwintering (Beardsley Jr and Gonzalez 1975). The hatched or live-born young remain motionless under the body or scale cover of the adult female for a short period of time before emerging as crawlers. Depending on the environmental conditions this time may vary from half an hour to a couple of days (Beardsley Jr and Gonzalez 1975; Koteja 1990b; Ben-Dov *et al.* 2012). Removal of the mother scale may also trigger the emergence of crawlers (Koteja 1990b).

Crawlers are the primary dispersal stage and move to new areas of the plant or are dispersed by wind or animal contact (Watson 2005). Although wind is an agent of dispersal, it can also cause mortality because crawlers dislodged by wind may not land on a suitable host plant (Beardsley Jr and Gonzalez 1975; Watson 2005). The dispersal phase or wandering period lasts for several hours to several days depending on the environmental conditions and availability of feeding sites (Koteja 1990b; Ben-Dov *et al.* 2012). At the end of the wandering period, crawlers secure themselves to the plant host with their mouthparts. Crawlers prefer to settle on the rough or dusty surfaces of the plant (Koteja 1990b). Once settled, the crawlers draw their legs beneath the body and flatten themselves against the host to commence feeding and develop a protective covering (Beardsley Jr and Gonzalez 1975; Koteja 1990b). They feed by inserting their piercing and sucking mouthparts into the plant tissue to consume the plant juices (Koteja 1990b). Dispersal of sessile adults and eggs occurs through human transport of infested plant material (Watson 2005).

The risk scenario of concern for *I. longirostris, P. cinerea* and *S. articulatus* is the presence of crawlers, immobile juveniles or adult scales on imported fresh lychee fruit.

The assessment of the armoured scales species listed here builds on the previous assessments as indicated above.

However, there are differences in horticultural practices, climatic conditions and the prevalence of the listed armoured scales between previous export areas (Indonesia, New Caledonia and the Philippines) and current areas (Taiwan and Vietnam) and in commodities (bananas, limes and mangosteens) other than lychees. These differences make it necessary to reassess the probability of entry, i.e. the likelihood that *P. cinerea* will be imported into and distributed within Australia and *I. longirostris* and *S. articulatus* within Western Australia with fresh lychee fruit from Taiwan and Vietnam.

The probability of establishment and of spread of the listed armoured scales in Australia and the consequences they may cause will be comparable for any commodity on which these species are imported into Australia, as these probabilities relate specifically to events that occur in Australia and are largely independent of the importation pathway. Accordingly, there is no need to reassess these components, and the estimates of the risk ratings for establishment, spread and consequences will be adopted from existing policies for the species.

4.2.1 Reassessment of probability of entry

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

Reassessment of probability of importation

The likelihood that *P. cinerea* will arrive in Australia and *I. longirostris* and *S. articulatus* will arrive in Western Australia with the importation of fresh lychee fruit from Taiwan and/or Vietnam is: **VERY LOW**.

Supporting information for this assessment is provided below:

- *Ischnaspis longirostris* and *S. articulatus* are present in Taiwan but not in Vietnam (Ben-Dov *et al.* 2012). *P. cinerea* is present in both Taiwan and in Vietnam (PPD 2010; Ben-Dov *et al.* 2012).
- Lychee is a known host for *I. longirostris, P. cinerea* and *S. articulatus* (Ben-Dov *et al.* 2012).
- Armoured scales usually settle, feed and reproduce on the aerial parts of the tree, particularly plant organs with a thick epidermal layer such as leaves, fruit and branches (Beardsley Jr and Gonzalez 1975; Kosztarab 1990).
- First instar nymphs or crawlers of these armoured scales are capable of moving onto the fruit where they permanently attach and commence feeding (Beardsley Jr and Gonzalez 1975). Subsequent nymphs and adults inside the scale covers are sessile and remain attached to the host plant.
- Armoured scales are considered as occasional pests of lychees in Taiwan and control is only applied when the pests are found in lychee orchards (BAPHIQ 2012b). There is no evidence that these three particular species have been reported on lychees in Taiwan, although Ben-Dov (2012) indicates lychees as their hosts.
- In Vietnam, armoured scales are not considered as main pests of lychees and this is evident in the VietGAP where no armoured scales were mentioned (PPD 2012c) although *Parlatoria cinerea* has been reported on lychees in Vietnam (PPD 2010).
- Adult females are small, approximately 1.0–1.5 mm in length (Takagi 1990). The small size of the adults, nymphs and eggs, may make them difficult to detect, especially at low populations. Therefore, armoured scales may not be easily detected and removed during sorting, grading and packing processes when they are present on fruit.
- Armoured scales overwinter as eggs, first instar nymphs or adult females (Beardsley Jr and Gonzalez 1975). It is feasible that these species of armoured scales would also survive during transportation of fresh lychee fruit under cold storage at 4–5 °C.

The small size, sessile nature of most life stages and cold tolerance of the armoured scales, moderated by the minor pest status and the apparent lack of records of these species on lychees in Taiwan and/or Vietnam, support a likelihood estimate for importation of 'very low'.

Reassessment of probability of distribution

The likelihood that *P. cinerea* will be distributed within Australia and *I. longirostris* and *S. articulatus* will be distributed within Western Australia, in a viable state as a result of the processing, sale or disposal of fresh lychee fruit from Taiwan and/or Vietnam and subsequently transfer to a susceptible part of a host is: **LOW**.

Supporting information for this assessment is provided below:

- Fresh lychee fruit may be distributed throughout Australia for retail sale during the months of May to August, as the intended use of the commodity is human consumption. Waste material will be generated.
- *Ischnaspis longirostris, P. cinerea* and *S. articulatus* eggs, nymphs and adults may remain on the fruit during retail distribution. The unconsumed parts of the fruit, especially the skin of infested lychee fruit, are likely to end up in fruit waste, which may further aid distribution of viable scales. Disposal of infested fruit waste is likely to be by commercial or domestic rubbish systems or where the fruit is consumed. Some fruit waste may be disposed of in the home garden which provides an opportunity for these pests to transfer to susceptible hosts in the vicinity.
- Eggs hatch within 5–7 days and become crawlers (Ben-Dov *et al.* 2012). Crawlers are the mobile stage of the species and can also be dispersed by wind (Watson 2005). The crawler stage of scales is rather short, lasting about 9 days (Ben-Dov *et al.* 2012).
- Other nymphal stages and adult females are sessile and not mobile (Beardsley Jr and Gonzalez 1975). Adult males have wings and are able to fly short distances but only live for a few days (Giliomee 1990; Koteja 1990b), limiting their dispersal ability.
- *Ischnaspis longirostris, P. cinerea* and *S. articulatus* are polyphagous and attack a number of host plants including fruit and nut trees, ornamental shade trees, flowering plants, palms, cacti, ground covers and forest trees (Ben-Dov *et al.* 2012). Host plants are widely available in Australia including Western Australia.

The possibility of dispersal near suitable hosts and the wide availability of hosts, moderated by the short dispersal stage of crawlers on infested fresh lychee fruit, and by the sessile status of other life stages, support a likelihood estimate for distribution of 'low'.

Overall probability of entry (importation × distribution)

The overall probability of entry is determined by combining the probabilities of importation and of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *P. cinerea* will enter Australia and *I. longirostris* and *S. articulatus* will enter Western Australia as a result of trade in fresh lychee fruit from Taiwan and/or Vietnam and be distributed in a viable state to a susceptible host is: **VERY LOW**.

4.2.2 Probability of establishment and spread

The probability of establishment and of spread for these armoured scales *I. longirostris, P. cinerea* and *S. articulatus* is based on the previous assessments indicated above. The ratings from the previous assessments are presented below:

Probability of establishment:	**HIGH**
Probability of spread:	**MODERATE**

4.2.3 Overall probability of entry, establishment and spread

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

The likelihood that *P. cinerea* will enter Australia and *I. longirostris* and *S. articulatus* will enter Western Australia as a result of trade in fresh lychee fruit from Taiwan and/or Vietnam, be distributed in a viable state to a susceptible host, establish in Australia or in Western Australia and subsequently spread within Australia or in Western Australia is: **VERY LOW**.

4.2.4 Consequences

The consequences of the establishment of *P. cinerea* in Australia and *I. longirostris* and *S. articulatus* in Western Australia have been estimated previously as indicated above. This estimate of impact scores is provided below. As the ratings for *P. cinerea* in Tahitian limes from New Caledonia (Biosecurity Australia 2006a) were conducted on a scale from A to F, they have been adjusted here to reflect the current rating scale from A to G and represented below together with *I. longirostris* and *S. articulatus*.

Plant life or health	**D**
Any other aspects of the environment	**B**
Eradication, control, etc.	**D**
Domestic trade	**C**
International trade	**C**
Environment	**B**

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

4.2.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Ischnaspis longirostris, Parlatoria cinerea* and *Selenaspidus articulatus*	
Overall probability of entry, establishment and spread	Very low
Consequences	Low
Unrestricted risk	Negligible

As indicated, the unrestricted risk estimate for *I. longirostris, P. cinerea* and *S. articulatus* of 'negligible' achieves Australia's ALOP. Therefore, no specific risk management measures are required for these pests.

4.3 Mealybugs [Hemiptera: Pseudococcidae]

These species has been assessed previously and import policy already exists as follows:

Dysmicoccus lepelleyi $^{\text{EP}}$	Mangosteens from Indonesia (DAFF 2012).
Paracoccus interceptus $^{\text{EP}}$	Mangosteens from Indonesia (DAFF 2012).
Planococcus lilacinus $^{\text{EP}}$	Durian from Thailand (AQIS 1999a); mangoes from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a); mangosteens from Indonesia (DAFF 2012).
Planococcus litchi $^{\text{EP, VN}}$	Longans and lychees from China and Thailand (DAFF 2004b).
Planococcus minor $^{\text{EP, WA}}$	Durian from Thailand (AQIS 1999a); banana from Philippines (Biosecurity Australia 2008b); mangosteens from Indonesia (DAFF 2012).
Pseudococcus cryptus $^{\text{EP}}$	Persimmon from Japan, Korea and Israel (DAFF 2004d); mangoes from Taiwan (Biosecurity Australia 2006b); mangosteens from Thailand (DAFF 2004a) and Indonesia (DAFF 2012).
Pseudococcus jackbeardsleyi $^{\text{EP}}$	Pineapples (AFFA 2002); mangoes from Taiwan (Biosecurity Australia 2006b); bananas from the Philippines (Biosecurity Australia 2008b); mangosteens from Indonesia (DAFF 2012).

Planococcus minor is not present in Western Australia and is a pest of regional quarantine concern for that state.

The biology and taxonomy of these seven mealybug species are considered sufficiently similar to justify combining them into a single assessment. In this assessment, the term 'mealybugs' is used to refer to these seven species unless otherwise specified.

Dysmicoccus lepelleyi (lepelleyi mealybug), *Paracoccus interceptus* (intercepted mealybug), *Planococcus lilacinus* (coffee mealybug), *P. litchi* (litchi mealybug), *P. minor* (pacific mealybug), *Pseudococcus cryptus* (cryptic mealybug), and *P. jackbeardsleyi* (Jack Beardsley mealybug) belong to the mealybug family Pseudococcidae.

Mealybugs are highly polyphagous and have been recorded on a wide range of host plants including lychees. Many mealybug species pose serious problems to agriculture when introduced into new areas of the world where natural enemies are not present (Miller and Miller 2002). Except *Planococcus litchi* which has not been reported in Taiwan (Ben-Dov 2011), all the other listed mealybug species are found in Taiwan and Vietnam.

Mealybugs are small, oval, soft-bodied insects that are covered with a white, cottony or mealy wax secretion that is moisture repellent and protects them against desiccation (Cox 1987; Furness and Charles 1994). Mealybugs are sucking insects that injure plants by extracting large quantities of sap. This weakens and stunts plants, causing leaf distortion, premature leaf drop, dieback and even plant death (Osborne *et al.* 2005). Mealybugs also act as vectors for several plant diseases by injecting toxins or plant pathogens into host plants (e.g. grapevine leafroll virus, mealybug pineapple wilt) (Pfeiffer and Schultz 1986; Rohrbach *et al.* 1988). Mealybugs detract from the appearance of the plant by contaminating bunches with egg sacs, nymphs and adults (Spangler and Agnello 1991). They may also deposit a waste product 'honeydew', on which ants like to feed, on the leaves and fruit. Honeydew may act as a substrate for sooty mould to grow on (Spangler and Agnello 1991).

Mealybugs develop through a number of nymphal (immature instar) stages before undergoing a final moult into the adult form. Female mealybugs have four instar stages (Williams 2004), with the adult female being similar in appearance to the nymphal stage and approximately 4 mm in length. This contrasts with male mealybugs, which have five instar stages (Williams 2004), with the adult male emerging from a cocoon as a tiny winged form. The adult males do not feed, having no mouthparts, and their sole purpose is to locate a female and mate. Mealybugs reproduce sexually or parthenogenically, that is, without a mate, and there may be multiple generations per year. Females can produce up to 800 eggs (Ooi *et al.* 2002) in compact waxy sacs attached to the stems, leaves or fruit of host plants. The females die shortly after the eggs are laid. The eggs hatch around 1–2 weeks later (Ooi *et al.* 2002) into tiny yellowish crawlers (first instar nymphs).

Mealybugs prefer warm, humid, sheltered sites away from adverse climatic conditions and natural enemies. Mealybug eggs, nymphs and adults are very small and even though they usually infest the leaves and stems of host plants, they may be found in crevices and protected spaces of lychee fruit. This makes them difficult to detect and potentially a serious problem in lychee production areas.

The risk scenario of concern for these mealybug species is the presence of eggs, nymphs or adult females on imported lychee fruit.

The assessment of the mealybug species listed here builds on the previous policies as indicated above.

However, there are differences in horticultural practices, climatic conditions and the prevalence of the listed mealybugs between previous export areas (China, Indonesia, India, Israel, Japan, Malaysia, South Korea, Taiwan, Thailand, and the Philippines) and current areas (Taiwan and Vietnam) and/or in commodities (bananas, durians, longans, mangosteens, persimmons and pineapples) rather than lychees. These differences make it necessary to reassess the probability of entry, i.e. the likelihood that the listed mealybugs will be imported into and distributed within Australia with lychee fruit from Taiwan and Vietnam.

The probability of establishment and of spread of the listed mealybugs in Australia and the consequences they may cause will be comparable for any commodity on which these species are imported into Australia, as these probabilities relate specifically to events that occur in Australia and are largely independent of the importation pathway. Accordingly, there is no need to reassess these components, and the estimates of the risk ratings for establishment, spread and consequences will be adopted from existing policies for the species.

4.3.1 Reassessment of probability of entry

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

Reassessment of probability of importation

The likelihood that *D. lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *P. litchi*, *Pseudococcus cryptus*, and *P. jackbeardsleyi* will arrive in Australia and *Planococcus minor* will arrive in Western Australia with the importation of fresh lychee fruit from Taiwan and/or Vietnam is: **HIGH.**

Supporting information for this assessment is provided below:

- *Paracoccus interceptus*, *Planococcus lilacinus*, *P. minor*, *Pseudococcus cryptus* and *P. jackbeardsleyi* are present both in Taiwan and Vietnam (Williams 2004; BAPHIQ 2004; PPD 2010; Ben-Dov 2011).
- *Dysmicoccus lepelleyi* has been intercepted on *Garcinia mangostana* from Taiwan to USA (Williams 2004). Although PPD (2012a) noted that *D. lepelleyi* is absent from Vietnam, Williams (2004) reports that it has been intercepted on lychees as well as other host plants from Vietnam to USA and on many other host plants from Vietnam to Russia.
- *Planococcus litchi* is present in Vietnam (PPD 2010) but not in Taiwan (Ben-Dov 2011).
- All these mealybugs have been found on lychee plants and /or fruit (Williams 2004; BAPHIQ 2004; PPD 2010; Ben-Dov 2011).
- Once mealybugs find a suitable feeding site, they insert their stylets (mouthparts) and suck sap from the host plant. This procedure anchors the mealybugs to the plant where they generally remain (Williams 2004). Once feeding begins, they secrete a waxy mealy coating that helps protect their bodies.
- Adult female mealybugs and nymphs (that is, immature male and female mealybugs) are small (1–4 mm), oval shaped, often inconspicuous, lack wings and have limited mobility (Spangler and Agnello 1991).
- Mealybugs on fruit are likely to be difficult to remove during cleaning, sorting and packing especially at low population levels.
- As these pests are small in size, they are unlikely to be detected during routine visual quality inspection procedures concerned primarily with quality standards of fruit as regards to blemishes, premature ripening and visible cracks, splits, pulled stem, puncture or break of the skin. The procedures are not specifically directed at the detection of small arthropod pests present on the fruit surface.
- These mealybugs are likely to survive storage and transportation. There is no data for the listed mealybugs regarding their tolerance to prolonged periods of cold temperatures or cold storage at 4-5°C. However, other mealybug species have been detected alive at on-arrival inspection in Australia on fresh lychee fruit (AQIS 2010). It is feasible that these species would also survive during transportation.

The association of mealybugs with the fruit, the small size, sessile and cryptic nature of most life stages plus their previous interception on arrival, all support a likelihood estimate for importation of ‘high’.

Reassessment of probability of distribution

The probability of distribution for *Planococcus litchi* was assessed as ‘moderate’ in the IRA for longans and lychee from China and Thailand (DAFF 2004b), which is adopted here. The following assessment is for the other six species, the distribution of which has not been assessed in DAFF (2004b).

The likelihood that *D. lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *Pseudococcus cryptus*, and *P. jackbeardsleyi* will be distributed within Australia and *Planococcus minor* will be distributed within Western Australia in a viable state as a result of the processing, sale or disposal of fresh lychee fruit from Taiwan and/or Vietnam and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Imported lychee fruit may be distributed throughout Australia for retail sale during the winter months of May to August, as the intended use of the commodity is human consumption. Waste material will be generated.
- Mealybug eggs, nymphs and adult females may remain on the fruit during retail distribution. The unconsumed parts of the fruit, especially the skin of infested fruit, are likely to end up in fruit waste, which may further aid distribution of viable mealybugs. Disposal of infested fruit is likely to be by commercial or domestic rubbish systems or where the fruit is consumed. Some fruit waste may be disposed of in the home garden which provides an opportunity for mealybugs to transfer to susceptible hosts in the vicinity.
- Adult females can only crawl a few metres, restricting their ability to move from discarded fruit waste to a suitable host (CABI 2012).
- However, mealybugs have a high fecundity, and can produce up to 800 eggs (e.g. *Planococcus lilacinus* and *P. minor* (Ooi *et al.* 2002)), which will hatch into crawlers.
- Crawlers (first instar nymphs) are the primary dispersal phase and are capable of active dispersal by crawling and passive dispersal by wind currents (Hely *et al.* 1982; Rohrbach *et al.* 1988). However, mealybugs can survive for only a short time (approximately one day) without feeding (Osborne *et al.* 2005).
- Mealybugs are polyphagous. A range of plants which are widely distributed in Australia can act as host for these pests (see Appendix B).
- Once mealybugs find a suitable feeding site they become sessile. They insert their stylets into the plant host and remain permanently attached.

The possibility of dispersal near a wide availability of suitable hosts and the high fecundity of mealybugs, moderated by the limited mobility and ability to only survive for a short time without feeding, all support a likelihood estimate for distribution of ‘moderate’.

Overall probability of entry (importation × distribution)

The overall probability of entry is determined by combining the probabilities of importation and of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *D. lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *P. litchi*, *P. minor*, *Pseudococcus cryptus*, and *P. jackbeardsleyi* will enter Australia as a result of trade in fresh lychee fruit from Taiwan and Vietnam and be distributed in a viable state to a susceptible host is: **MODERATE**.

4.3.2 Probability of establishment and spread

The probability of establishment and of spread for *D. lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *P. litchi*, *P. minor*, *Pseudococcus cryptus*, and *P. jackbeardsleyi* is based on the previous assessments indicated above. The ratings from the previous assessments are presented below:

Probability of establishment:	**HIGH**
Probability of spread:	**HIGH**

4.3.3 Overall probability of entry, establishment and spread

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

The likelihood that *D. lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *P. litchi*, *P. minor*, *Pseudococcus cryptus*, and *P. jackbeardsleyi* will enter Australia as a result of trade in fresh lychee fruit from Taiwan and/or Vietnam, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **MODERATE.**

4.3.4 Consequences

The consequences of the establishment of *D. lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *P. litchi*, *Pseudococcus cryptus*, and *P. jackbeardsleyi* in Australia and *Planococcus minor* in Western Australia have been estimated previously. This estimate of impact scores is provided below. As the ratings for some species were conducted on a scale from A to F, they have been adjusted here to reflect the current rating scale from A to G.

Plant life or health	**D**
Any other aspects of the environment	**B**
Eradication, control etc.	**D**
Domestic trade	**C**
International trade	**D**
Environment	**B**

Based on the description rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria have an impact of '**D**', the overall consequences are estimated to be **LOW**.

4.3.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Dysmicoccus lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *Planococcus litchi, Planococcus minor, Pseudococcus cryptus* and *Pseudococcus jackbeardsleyi*	
Overall probability of entry, establishment and spread	Moderate
Consequences	Low
Unrestricted risk	Low

As indicated, the unrestricted risk estimate for *D. lepelleyi*, *Paracoccus interceptus*, *Planococcus lilacinus*, *P. litchi*, *P. minor*, *Pseudococcus cryptus*, and *P. jackbeardsleyi* of ‘low’ exceeds Australia’s ALOP. Therefore, specific risk management measures are required for these pests.

4.4 Litchi fruit borer [Lepidoptera: Gracillariidae]

Conopomorpha sinensis EP

Conopomorpha sinensis, litchi fruit borer, belongs to the moth family Gracillariidae and is a pest of both lychee and longan (Waite and Hwang 2002).

Conopomorpha sinensis has four life stages: egg, larva, pupa and adult. The adult body is very small and narrow, with long filiform antennae and a wingspan of 8-11 mm. Eggs are yellow, scale-like and 0.4 x 0.2 mm. Hatched larvae immediately penetrate the fruit, leaves or shoots and only one larva per fruit survives. Mature larvae are brownish, or green if they feed on leaves, and 6-10 mm long. Pupation occurs on or under mature leaves in cream-coloured oval cocoons (Waite and Hwang 2002).

The risk scenario of concern for *Conopomorpha sinensis* is the presence of larvae within imported fresh lychee fruit.

The assessment of *Conopomorpha sinensis* presented here builds on the previous policy for longans and lychees from China and Thailand (DAFF 2004b).

The probability of importation for *Conopomorpha sinensis* was rated as ‘high’ in the assessments for longans and lychees from China and Thailand (DAFF 2004b). However, differences in horticultural practices, climatic conditions and the prevalence of *C. sinensis* between previous export areas (China and Thailand) and current areas (Taiwan and Vietnam) make it necessary to reassess the likelihood that *C. sinensis* will be imported into Australia with fresh lychee fruit from Taiwan and Vietnam.

The probability of distribution of *C. sinensis* in Australia will be the same for lychees from China and Thailand (DAFF 2004b) and the probability of establishment and of spread of *C. sinensis* in Australia, and the consequences it may cause will be comparable for any commodity in which the species are imported into Australia, as these probabilities relate specifically to events that occur in Australia and are largely independent of the importation pathway. Accordingly, there is no need to reassess these components and previous assessments are adopted for the species.

4.4.1 Reassessment of probability of importation

The likelihood that *C. sinensis* will arrive in Australia with the importation of fresh lychee fruit from Taiwan and Vietnam is: **HIGH**.

Supporting information for this assessment is provided below:

- *Conopomorpha sinensis* is a common and major pest on lychees in both Taiwan and Vietnam (BAPHIQ 2004; PPD 2010).
- *Conopomorpha sinensis* lays yellow, scale-like eggs on the fruit anytime after fruit set as well as on new leaves and shoots of lychees (Waite and Hwang 2002).
- After hatching, the larvae penetrate into the fruit, leaf or shoot, and one or more eggs may be laid on one fruit but only one larva per fruit survives (Waite and Hwang 2002).
- It is unlikely that larva of *C. sinensis* inside fruit will be detected during sorting and packing procedures because litchi fruit borer is an internal pest and the entry point is obscured when the fruit grow.
- Inspection procedures carried out in the packing station are concerned primarily with quality standards of fruit as regards to blemishes, premature ripening and visible cracks,

splits, pulled stem, puncture or break of the skin and will only pick up fruit with external damage by the borer.

- *Conopomorpha sinensis* will be able to survive cold storage and transportation of lychee fruit to Australia because live insects were reported to be intercepted in cold-treated fresh lychee fruit from China to the US (USDA-APHIS 2008).

The ability of *C. sinensis* larvae to feed and develop in fresh lychee fruit, their internal habitat and interception on exported fresh lychee fruit all support a likelihood estimate for importation of 'high'.

4.4.2 Probability of distribution, of establishment and of spread

The probability of distribution, of establishment and of spread for *C. sinensis* will be the same as that assessed for longans and lychees from China and Thailand (DAFF 2004b). The likelihood estimates from the previous assessments are presented below:

Probability of distribution:	**MODERATE**
Probability of establishment:	**LOW**
Probability of spread:	**MODERATE**

4.4.3 Overall probability of entry, establishment and spread

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

The likelihood that *C. sinensis* will enter Australia as a result of trade in lychees from Taiwan and Vietnam, be distributed in a viable state to a susceptible host, establish in that area and subsequently spread within Australia: **LOW**.

4.4.4 Consequences

The consequences of the establishment of *C. sinensis* in Australia have been estimated previously for longans and lychees from China and Thailand (DAFF 2004b). As the ratings were conducted on a scale from A to F, they have been adjusted here to reflect the current rating scale from A to G. This estimate of impact scores is provided below.

Plant life or health	**C**
Any other aspects of the environment	**B**
Eradication, control, etc.	**C**
Domestic trade	**C**
International trade	**E**
Environment	**C**

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

4.4.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Conopomorpha sinensis*	
Overall probability of entry, establishment and spread	Low
Consequences	Moderate
Unrestricted risk	Low

As indicated, the unrestricted risk estimate for *C. sinensis* of ‘low’ exceeds Australia’s ALOP. Therefore, specific risk management measures are required for this pest.

4.5 Summer fruit tortrix moth [Lepidoptera: Tortricidae]

This species has been assessed previously and import policy already exists as follows:

Adoxophyes orana $^{\mathrm{EP,\ TW}}$	Pears from China (AQIS 1998b; Biosecurity Australia 2003; Biosecurity Australia 2005), apples from Japan (AQIS 1998a) and China (Biosecurity Australia 2010), longans and lychees from China and Thailand (DAFF 2004b).

Adoxophyes orana, summer fruit tortrix moth, belongs to the insect family Tortricidae and is a major pest of apples, pears and stone fruit (CABI 2012).

Adoxophyes orana has four life stages: egg, larva, pupa and adult (Ma 2006). There is apparently no study of the life cycle of *A. orana* on lychee and information on apple from Ma (2006) is presented here. Adults are yellow-brown and 6-8 mm long, with a wingspan of 15-20 mm. Eggs are about 0.7 mm, and are laid in rows, mainly on the surface of leaves, but also can be found on the back of leaves, fruit and trunks of apple and other fruit trees. Larvae are slender, 13-18 mm in length, and have soft smooth skin and fine sparse hairs. Newly hatched larvae congregate to feed on the back of leaves, or in the existing leaf rolls and then disperse to roll their own leaf. As the larvae develop, they can also move onto fruit. Pupation occurs in the feeding sites, pupae are 9-11 mm long. This species may have one to four generations per year (Ma 2006).

The risk scenario of concern for *A. orana* is that larvae may move onto and bore into and remain undetected within imported fresh lychee fruit.

Adoxophyes orana has been assessed previously. The assessment of *A. orana* presented here builds on the previous assessements. Note that full risk assessments of *A. orana* were only undertaken for longans and lychees from China and Thailand (DAFF 2004b) and apples from China (Biosecurity Australia 2010).

However, differences in horticultural practices, climatic conditions and the prevalence of *A. orana* between previous export areas (China and Thailand) and the current area (Taiwan) make it necessary to reassess the likelihood that *A. orana* will be imported into Australia with fresh lychee fruit from Taiwan.

The probability of distribution of *A. orana* in Australia will be the same for lychees from China and Thailand (DAFF 2004b) and the probability of establishment and of spread of *A. orana* in Australia, and the consequences it may cause will be comparable for any commodity in which the species is imported into Australia, as these probabilities relate specifically to events that occur in Australia and are largely independent of the importation pathway. Accordingly, there is no need to reassess these components and previous assessments are adopted for the species.

4.5.1 Reassessment of probability of importation

The likelihood that *A. orana* will arrive in Australia with the importation of fresh lychee fruit from Taiwan is: **EXTREMELY LOW**.

Supporting information for this assessment is provided below:

- *Adoxophyes orana* is reported in Kaohsiung, Taiwan (Razowski 2000).
- *Adoxophyes orana* has been reported on lychee in mainland China (Huang *et al.* 1997). However, this species was not mentioned in the survey of lepidopterous pests on lychee in Taiwan by Hung *et al.* (2006) and has never been reported as a pest of lychee in Taiwan, although there is record of *A. orana* in Taiwan by Razowski (2000).
- Larvae of *A. orana* typically spin a leaf against a fruit and damage on fruit is mostly at the spots where such a leaf is attached to the fruit (CABI 2012).
- The fruit damage either consists of large deep holes by the first generation of larvae or very superficial and small holes of less than 5 mm in diameter by the second generation of larvae. Most damaged young fruit will fall or the wounds recover and are visible as corky, well-shaped areas (CABI 2012). Damaged fruit will likely be eliminated during harvesting and sorting.
- When disturbed, the larvae will drop from the tree on a spun silken thread (CABI 2012).

The evidence that this species has not been found on lychee in Taiwan, that the damaged fruit would show obvious symptoms, and that larvae drop from the trees when disturbed all support a likelihood estimate for importation of ‘extremely low’.

4.5.2 Probability of distribution, of establishment and of spread

The probability of distribution was assessed as low for longans and lychees from China and Thailand (DAFF 2004b) and as moderate for apples from China (Biosecurity Australia 2010). After careful consideration, it would be reasonable to accept the rating of ‘low’ for the probability of distribution here due to the same commodity.

The probability of establishment and of spread for *A. orana* was both assessed as moderate for longans and lychees from China and Thailand (DAFF 2004b) and as high for apples from China (Biosecurity Australia 2010). After careful consideration and review of the evidence provided, it is concluded that the rating of ‘high’ would be accepted for both the probability of establishment and the probability of spread because the evidence presented in apples from China (Biosecurity Australia 2010) supports such ratings.

The likelihood estimates from the previous assessments are presented below:

Probability of distribution:	**LOW**
Probability of establishment:	**HIGH**
Probability of spread:	**HIGH**

4.5.3 Overall probability of entry, establishment and spread

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

The likelihood that *A. orana* will enter Australia as a result of trade in lychees from Taiwan and Vietnam, be distributed in a viable state to a susceptible host, establish in that area and subsequently spread within Australia: **EXTREMELY LOW**.

4.5.4 Consequences

The consequences of the establishment of *A. orana* in Australia have been estimated previously for longans and lychees from China and Thailand (DAFF 2004b) and apples from China (Biosecurity Australia 2010). After careful consideration and review of the evidence provided, the impact scores provided in apples from China (Biosecurity Australia 2010) have been accepted because the evidence clearly supports the scores. Thus this estimate of impact scores is provided.

Plant life or health	**E**
Any other aspects of the environment	**B**
Eradication, control, etc.	**E**
Domestic trade	**D**
International trade	**D**
Environment	**B**

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

4.5.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Adoxophyes orana*	
Overall probability of entry, establishment and spread	Extremely low
Consequences	Moderate
Unrestricted risk	Negligible

As indicated, the unrestricted risk estimate for *A. orana* of 'negligible' achieves Australia's ALOP. Therefore, no specific risk management measures are required for this pest.

4.6 Downy blight [Peronosporales: Peronosporaceae]

Phytophthora litchii EP

Phytophthora sp. VN

Phytophthora litchii, downy blight or litchi brown blight, belongs to the family Peronosporaceae. This species was isolated from diseased lychee fruit and originally described as *Peronophythora litchii* CC Chen (Chen 1961). However, since Chen (1961) did not designate the nomenclatural type specimens, that name was not valid. The same name *Peronophythora litchii* was made valid by the work of Ko *et al.* (1978). In 2007, the species was moved to the genus *Phytophthora* and the current valid full name is *Phytophthora litchii* (CC Chen ex WH Ko, HS Chang, HJ Su, CC Chen & LS Leu) Voglmayr, Göker, Riethm. & Oberw. (Mycobank 2012).

Downy blight is a disease of lychee, causing circular, pale blackish lesions in the rind of the fruit, mainly confined to the contact portion of two adjacent fruit. The circular lesions have distinct margins and are 1.0–1.5 cm in diameter. Two thirds of the lesion are generally covered with pale yellowish aerial mycelia, especially on the contact surface of the adjacent fruit (Chen 1961).

Phytophthora sp. is reported as being on leaves and fruit of lychee in Vietnam in addition to two other species of the same genus – *Peronophythora litchii* (now *Phytophthora litchii* and assessed here) and *Phytophthora cinnamomi* (not considered further due to its presence in Australia) by PPD (2010). There is no other information available for *Phytophthora* sp. and thus it is here assessed together with the co-generic species *Phytophthora litchii,* as the biology of the two species is likely to be the same or very similar.

The risk scenario of concern for *P. litchii* and *P.* sp. is that they may be present on imported fresh lychee fruit.

Phytophthora litchii has been assessed previously as *Peronophythora litchii* (DAFF 2004b). The assessment of *P. litchii* presented here builds on the previous policy.

However, differences in horticultural practices, climatic conditions and the prevalence of *P. litchii* between previous export areas (China and Thailand) and current areas (Taiwan and Vietnam) make it necessary to reassess the likelihood that *P. litchii* will be imported into Australia with fresh lychee fruit from Taiwan and Vietnam.

The probability of distribution of *P. litchii* in Australia will be the same for lychees from China and Thailand (DAFF 2004b) and the probability of establishment and of spread of *P. litchii* in Australia, and the consequences it may cause will be comparable for any commodity in which the species is imported into Australia, as these probabilities relate specifically to events that occur in Australia and are largely independent of the importation pathway. Accordingly, there is no need to reassess these components and previous assessments are adopted for the species.

4.6.1 Reassessment of probability of importation

The likelihood that *P. litchii* and *P.* sp. will arrive in Australia with the importation of fresh lychee fruit from Taiwan and/or Vietnam is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Phytophthora litchii* is found in Taiwan (BAPHIQ 2004) and Vietnam (PPD 2010).
- *Phytophthora* sp. is reported on leaves and fruit of lychee in Thai Nguyen, Vietnam (2010)
- *Phytophthora litchii* is common in lychee orchards in both Taiwan (BAPHIQ 2012a) and Vietnam (PPD 2010; PPD 2012b).
- Symptoms of downy blight on lychee fruit are obvious. An almost circular, pale blackish lesion with distinct margins and 1.0–1.5 cm in diameter is formed in the rind of the fruit, mainly confined to the contact portion of two adjacent fruit (Chen 1961).
- Control measures are routinely applied in Taiwan and Vietnam for the disease starting from the flower budding and fruitlet stage (BAPHIQ 2012a; PPD 2012b). For example, chemical spraying is carried out 5–6 times at 7–10 day intervals before fruit maturity in Taiwan (BAPHIQ 2012a).
- The disease causes fruit rot and massive premature fruit fall from the tree (BAPHIQ 2012a).
- Visibly infected fruit are unlikely to be picked or would be discarded during routine inspection and sorting; however, it is possible that infected fruit with minor symptoms may be overlooked and could be exported.

The evidence that the pathogens are widespread and common in lychee production areas of Taiwan and Vietnam and minor symptoms on fruit may be overlooked, moderated by premature fall of most infected fruit, active control measures in place in both Taiwan and Vietnam, and unlikely harvest of diseased fruit support a likelihood estimate for importation of ‘moderate’.

4.6.2 Probability of distribution, of establishment and of spread

As indicated, the probability of distribution, of establishment and of spread for *Phytophthora litchii* will be the same as that assessed for longans and lychees from China and Thailand (DAFF 2004b). It is assumed that *Phytophthora* sp. would be the same as for *Phytophthora litchii* in these aspects. The likelihood estimates from the previous assessments are presented below:

Probability of distribution:	**HIGH**
Probability of establishment:	**LOW**
Probability of spread:	**LOW**

4.6.3 Overall probability of entry, establishment and spread

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

The likelihood that *P. litchii* and *P.* sp. will enter Australia as a result of trade in lychees from Taiwan and Vietnam, be distributed in a viable state to a susceptible host, establish in that area and subsequently spread within Australia: **VERY LOW**.

4.6.4 Consequences

The consequences of the establishment of *P. litchii* in Australia have been estimated previously for longans and lychees from China and Thailand (DAFF 2004b). It is assumed that *Phytophthora* sp. would have the same consequences as *Phytophthora litchii.* As the ratings were conducted on a scale from A to F in DAFF (2004b), they have been adjusted here to reflect the current rating scale from A to G. This estimate of impact scores is provided below.

Plant life or health	**D**
Any other aspects of the environment	**B**
Eradication, control, etc.	**C**
Domestic trade	**C**
International trade	**C**
Environment	**C**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria have an impact of '**D**', the overall consequences are estimated to be **LOW**.

4.6.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Phytophthora litchii* and *P.* sp.	
Overall probability of entry, establishment and spread	Very low
Consequences	Low
Unrestricted risk	Negligible

As indicated, the unrestricted risk estimate for *P. litchii* and *P.* sp. of 'negligible' meets Australia's ALOP. Therefore, no specific risk management measures are required for this pest.

4.7 Pest risk assessment conclusions

Table 4.2 summarises the conclusions from the detailed risk assessments for the quarantine pests associated with fresh lychee fruit for human consumption from Taiwan and/or Vietnam.

Any pest with an unrestricted risk estimate of ‘low’, ‘moderate’ ‘high’ or ‘extreme’ does not meet Australia’s ALOP and requires risk management measures in addition to the standard commercial lychee production practices in Taiwan and Vietnam.

Table 4.2 **Summary of unrestricted risk estimates for quarantine pests associated with fresh lychee fruit from Taiwan and Vietnam**

Pest name	**Likelihood of**						**Consequences**							**URE**
	Entry			**Establishment**	**Spread**	**P[EES]**								
	Importation	Distribution	**Overall**				Direct		Indirect				**Overall**	
							PLH	**OE**	**EC**	**DT**	**IT**	**ENC**		
Fruit flies [Order: Tephritida]														
Bactrocera cucurbitae ^{EP}	H	H	H	H	H	H	E	C	F	E	E	D	H	**High**
Bactrocera dorsalis ^{EP}														
Armoured scales [Hemiptera: Diaspididae]														
Ischnaspis longirostris' $^{EP, TW, WA}$	VL	L	VL	H	M	VL	D	B	D	C	C	B	L	**Negligible**
Parlatoria cinerea ^{EP}														
Selenaspidus articulatus $^{EP, TW, WA}$														
Mealybugs [Hemiptera: Pseudococcidae]														
Dysmicoccus lepelleyi ^{EP}	H	M	M	H	H	M	D	B	D	C	D	B	L	**Low**
Paracoccus interceptus ^{EP}														
Planococcus lilacinus ^{EP}														
Planococcus litchi ^{EP}														
Planococcus minor $^{EP, WA}$														
Pseudococcus cryptus ^{EP}														
Pseudococcus jackbeardsleyi ^{EP}														
Litchi fruit borer [Lepidoptera: Gracillariidae]														
Conopomorpha sinensis ^{EP}	H	M	M	L	M	L	C	B	C	C	E	C	M	**Low**
Summer fruit tortrix [Lepidoptera: Tortricidae]														
Adoxophyes orana $^{EP, TW}$	EL	L	EL	H	H	EL	E	B	E	D	D	B	M	**Negligible**

Pest name	**Likelihood of**						**Consequences**							**URE**
	Entry			**Establishment**	**Spread**	**P[EES]**								
	Importation	Distribution	**Overall**				Direct		Indirect				**Overall**	
							PLH	**OE**	**EC**	**DT**	**IT**	**ENC**		
Downy blight [Peronosporales: Peronosporaceae]														
Phytophthora litchii ^{EP}	M	H	M	L	L	VL	D	B	C	C	C	C	L	**Negligible**
Phytophthora sp. ^{VN}														

Abbreviations for superscript

EP	pests for which policy already exists.
TW	species has been reported in Taiwan but not in Vietnam
VN	Species has been reported in Vietnam but not in Taiwan
WA	regional quarantine pests of the state of Western Australia

Abbreviations for likelihoods for entry, establishment and spread

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

Abbreviation for assessment of consequences from pest entry, establishment and spread

PLH	plant life or health
OE	other aspects of the environment
EC	eradication, control etc.
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 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

.

5 Pest risk management

This section provides information on the management of quarantine pests identified with an unrestricted risk exceeding Australia’s appropriate level of protection (ALOP). The recommended phytosanitary measures are described below.

5.1 Pest risk management measures and phytosanitary procedures

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 above Australia’s ALOP. In calculating the unrestricted risk, existing commercial production practices in Taiwan and Vietnam have been considered, as have post-harvest procedures and the packing of fruit.

In addition to Taiwan and Vietnam’s existing commercial production practices for fresh lychee fruit, specific pest risk management measures, including operational systems, are proposed to achieve Australia's ALOP.

In this section, DAFF has identified risk management measures that may be applied to consignments of fresh lychee fruit sourced from Taiwan and Vietnam. Finalisation of the quarantine conditions may be undertaken with input from the Australian states and territories as appropriate.

The pest risk management measures recommended by DAFF for the management of identified quarantine pests are based on the mandatory requirement for Taiwan and Vietnam to adhere to existing commercial practices (refer to Section 3) of fresh lychee fruit for export to Australia.

The proposed pest risk management measures will apply to all the lychee production areas from which Taiwan and Vietnam intend to export fresh lychee fruit to Australia.

5.1.1 Pest risk management for quarantine pests

The pest risk analysis identified the quarantine pests listed in Table 5.1 as having an unrestricted risk above Australia’s ALOP.

When the following proposed pest management practices are followed, the restricted risk for all identified quarantine pests will achieve Australia’s ALOP.

Table 5.1 Phytosanitary measures proposed for quarantine pests for fresh lychee fruit from Taiwan and Vietnam

Pest	Common name	Measures
Bactrocera cucurbitae $^{\mathrm{EP}}$	Melon fruit fly	– cold disinfestation; OR – vapour heat treatment; OR – irradiation
Bactrocera dorsalis $^{\mathrm{EP}}$	Oriental fruit fly	
Conopomorpha sinensis $^{\mathrm{EP}}$	Litchi fruit borer	– cold disinfestation; OR – orchard control, inspection and remedial action; OR – orchard freedom; OR – irradiation
Dysmicoccus lepelleyi $^{\mathrm{EP}}$	Lepelleyi mealybug	– visual inspection and remedial action*; OR – irradiation
Paracoccus interceptus $^{\mathrm{EP}}$	Intercepted mealybug	
Planococcus lilacinus $^{\mathrm{EP}}$	Coffee mealybug	
Planococcus litchi $^{\mathrm{EP,\,VN}}$	Litchi mealybug	
Planococcus minor $^{\mathrm{EP,\,WA}}$	Passionvine mealybug	
Pseudococcus cryptus $^{\mathrm{EP}}$	Citriculus mealybug	
Pseudococcus jackbeardsleyi $^{\mathrm{EP}}$	Jack Beardsley mealybug	

*: Remedial action (depending on the location of the inspection) may include: treatment of the consignment to ensure that the pest is no longer viable; withdrawing the consignment from export to Australia; export of the consignment from Australia; or destruction of the consignment.

$^{\mathrm{EP}}$: Species has been assessed previously and import policy already exists.

$^{\mathrm{VN}}$: Species has been reported in Vietnam but not in Taiwan.

$^{\mathrm{WA}}$: Regional pest for the state of Western Australia.

This non-regulated analysis builds on the existing policy for longans and lychees from China and Thailand (DAFF 2004b), which includes the main pests identified in Table 5.1.

This draft report proposes that when the following pest management measures combined with an operational system are followed, the restricted risk for all identified quarantine pests assessed achieves Australia's appropriate level of protection (ALOP). They include:

- pest management measures including:
  - cold disinfestation treatment or vapour heat treatment (VHT) for the management of fruit flies
  - cold disinfestation treatment; or orchard control; inspection and remedial action; or orchard freedom for the management of litchi fruit borer
  - visual inspection and remedial action for the management of mealybugs

    OR

  - irradiation for the identified quarantine pests listed in Table 5.1
- supporting operational maintenance systems and verification of phytosanitary status.

Management for fruit flies

The fruit flies, *Bactrocera cucurbitae* and *B. dorsalis* were assessed to have an unrestricted risk estimate of 'high' that exceeds Australia's ALOP. Measures are therefore required to manage these risks.

DAFF proposes cold disinfestation treatment (CT), or vapour heat treatment (VHT) to reduce the risks associated with *Bactrocera cucurbitae* and *B. dorsalis* to meet Australia's ALOP.

Cold treatment

Cold treatment is an option to manage the risk of *B. cucurbitae* and *B. dorsalis* for the import of lychees from China and Thailand (DAFF 2004b). USDA treatment schedule *T107-j* (USDA-APHIS 2008) is considered adequate to mitigate the risk of fruit flies for lychees from Taiwan and Vietnam to meet Australia's ALOP.

The details of *T107-j* are:

- 0.99 °C or below for 15 days; or
- 1.38 °C or below for 18 days.

DAFF is in the process of reviewing this treatment schedule for lychees to ensure the consistency of this cold treatment option across the importation of fresh lychee fruit into Australia.

Vapour heat treatment (VHT)

Vapour heat treatment has been used for the importation of fresh lychee fruit from China and Thailand (DAFF 2004b). DAFF proposes that the same VHT schedule be employed for the importation of fresh lychee fruit from Taiwan and Vietnam to mitigate the risk of fruit flies.

The schedule requires a pre-export VHT at:

- 47.0 °C (fruit pulp temperature) or above for 15 minutes; or
- 46.0 °C (fruit pulp temperature) or above for 20 minutes.

Treatment time will be for a minimum of two hours, including the warming and cooling periods to bring the fruit pulp to required temperature. Treatment commences when the pulp core temperature of all probe monitored fruit reaches the required treatment temperature, and this temperature is maintained for the required period.

Conclusion

The objective of cold treatment or VHT is to reduce the likelihood of importation for the listed fruit fly species to at least 'extremely low'. The restricted risk would then be reduced to at least 'very low' which would achieve Australia's ALOP.

Management for mealybugs

The mealybugs (*Dysmicoccus lepelleyi, Paracoccus interceptus, Planococcus lilacinus, Planococcus litchi* $^{\mathrm{VN}}$, *Planococcus minor, Pseudococcus cryptus, Pseudococcus jackbeardsleyi*) were assessed to have an unrestricted risk estimate of 'low' that exceeds Australia's ALOP. Measures are therefore required to manage these risks.

DAFF proposes visual inspection and remedial action to reduce the risks associated with these mealybugs to meet Australia's ALOP.

Inspection and remedial action

Inspection and remedial action is recommended and used for lychees from China and Thailand (DAFF 2004b) and is considered adequate for lychees from Taiwan and Vietnam. Detached fresh lychee fruit will be inspected for the presence of mealybugs during pre-export inspection and on-arrival inspection. If infested fruit was not inspected and found free from these mealybugs, or remedial action was not undertaken, these mealybugs could enter, establish and spread in Australia.

Conclusion

The objective of visual inspection and remedial action is to reduce the likelihood of importation for the listed mealybug species to at least 'moderate'. The restricted risk would then be reduced to at least 'very low' which would achieve Australia's ALOP.

Management for litchi fruit borer

The litchi fruit borer, *Conopomorpha sinensis*, has been assessed to have an unrestricted risk of 'low', which exceeds Australia's ALOP. Measures are therefore required to manage this risk.

DAFF proposes cold treatment, or orchard control and inspection and remedial action, to reduce the risks associated with litchi fruit borer to meet Australia's ALOP. These measures have been employed for the importation of lychees from China and Thailand (DAFF 2004b).

In addition, Vietnam's PPD has enquired about orchard freedom as a management option for litchi fruit borer. Orchard freedom, when undertaken properly in accordance with the ISPM 10 *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999), is considered adequate to reduce the risk associated with litchi fruit borer to meet Australia's ALOP.

Cold treatment

Cold treatment is an option to mitigate the risk of litchi fruit borer for import of fresh lychee fruit from China and Thailand (DAFF 2004b) and has been used by both countries for their export of lychees to Australia.

This cold treatment schedule would manage the risk of both fruit flies (*Bactrocera cucurbitae* and *Bactrocera dorsalis*) and litchi fruit borer (*Conopomorpha sinensis*) in lychees from Taiwan and Vietnam.

DAFF proposes an option of pre-export/in-transit cold treatment, consistent with the current USDA cold treatment schedule of *T107-h* (USDA-APHIS 2008), at

- 0.99 °C or below for 17 days; or
- 1.38 °C or below for 20 days.

This cold treatment schedule would manage the risk of both fruit flies (*Bactrocera cucurbitae* and *Bactrocera dorsalis*) and litchi fruit borer (*Conopomorpha sinensis*) in lychees from Taiwan and Vietnam.

DAFF is in the process of reviewing this treatment schedule for lychees to ensure the consistency of this cold treatment option across the importation of fresh lychee fruit into Australia.

Orchard control, visual inspection and remedial action

This option of managing *Conopomorpha sinenesis* is recommended and used for lychees from China and Thailand (DAFF 2004b), usually in association with VHT option for fruit flies, and is considered adequate for lychees from Taiwan and Vietnam. The measure requires an NPPO-approved orchard control program and inspection for freedom from *Conopomorpha sinenesis*. The orchard control program for *Conopomorpha sinenesis* may include an Integrated Pest Management (IPM) program using appropriate, effective and compatible measures at critical stages of development of the pest and crop. Measures should be based on pest monitoring orchard inspections and forecasts of infestations.

Information on the NPPO-approved orchard control program for *Conopomorpha sinenesis* must be made available to DAFF if requested.

Harvested fruit will be inspected specifically for evidence of *Conopomorpha sinenesis*.

The combination of orchard control and targeted visual inspection for freedom from this pest during pre-export inspection and on-arrival inspection would reduce the risk of *Conopomorpha sinenesis* associated with the importation of lychee fruit from Taiwan and Vietnam to an acceptable level. If *Conopomorpha sinenesis* is found during these inspections then remedial action must be taken, which may include treatment of the consignment to ensure that the pest is no longer viable; withdrawing the consignment from export to Australia; export of the consignment from Australia; or destruction of the consignment.

Orchard freedom

Vietnam specifically enquired about orchard freedom as an option to manage the risk of *Conopomorpha sinenesis* during DAFF's verification visit to Vietnam's lychee production areas in June 2012. It should be pointed out that the requirements for orchard freedom are different from those for *Orchard control, visual inspection and remedial action* proposed above.

DAFF is willing to assess any written proposal from Vietnam or Taiwan to nominate orchard freedom based on the requirements for pest free place of production or pest free production site as a measure to manage the risk posed by litchi fruit borer. The requirements are set out in ISPM No. 10 *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999).

Conclusion

The objective of cold treatment; or orchard control, visual inspection and remedial action; or pest free place of production or pest free production site is to reduce the likelihood of importation for the litchi fruit borer to at least 'very low'. The restricted risk would then be reduced to at least 'very low' which would achieve Australia's ALOP.

Irradiation for fruit flies, mealybugs and litchi fruit borer

Use of irradiation as a phytosanitary measure is documented in the ISPM 18: *Guidelines for the use of irradiation as a phytosanitary measure* (FAO 2003), which outlines a number of issues for consideration in accepting irradiation as a phytosanitary measure.

The arthropod pests identified in this risk analysis report comprise two fruit flies (*Bactrocera cucurbitae* and *B. dorsalis*), litchi fruit borer (*Conopomorpha sinensis*) and seven mealybugs (*Dysmicoccus lepelleyi, Paracoccus interceptus, Planococcus lilacinus, Planococcus litchi* ^{VN}, *Planococcus minor, Pseudococcus cryptus, Pseudococcus jackbeardsleyi*).

FAO (2003) provides an estimated minimum absorbed dose for certain responses for selected pest groups. The minimum absorbed doses for the relevant insect groups are:

- 50–250 Gray (Gy) for fruit flies to prevent adult emergence from 3rd instar larvae
- 100–280 Gy for lepidopteran borers to prevent adult development from late larva

There are no dose recommendations for mealybugs in FAO (2003).

USDA (2010) provided a specific dose of 150 Gy for *Bactrocera cucurbitae* and *Bactrocera dorsalis. Conopomorpha sinensis* and mealybug species are not included and 400 Gy is recommended as minimum absorbed dose for plant pests of the class Insecta not listed in USDA (2010).

Based on the above information, the following minimum absorbed dose is proposed to mitigate the risks posed by the quarantine pests from Taiwan and/or Vietnam.

- 150 Gy for *Bactrocera cucurbitae* and *Bactrocera dorsalis*
- 400 Gy for *Conopomorpha sinensis*, *Dysmicoccus lepelleyi*, *Paracoccus interceptus, Planococcus lilacinus, Planococcus litchi, Planococcus minor, Pseudococcus cryptus* and *Pseudococcus jackbeardsleyi*

Conclusion

The objective of irradiation is to prevent the introduction or spread of the identified pests by causing inactivation or mortality of the pests; preventing their successful development; or ensuring their inability to reproduce (FAO 2003).

5.1.2 Consideration of alternative measures

DAFF will consider any alternative measure proposed by Taiwan or Vietnam, providing that it achieves Australia's ALOP and is consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms* (FAO 2004). Evaluation of such measures or treatments will require a technical submission from Taiwan or Vietnam that details the proposed treatment and including data from suitable treatment trials to demonstrate 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 fresh lychee fruit from Taiwan and Vietnam. This is to ensure that the proposed risk management measures have been met and are maintained.

It is proposed that Taiwan's BAPHIQ and Vietnam's PPD, respectively, or other relevant agency nominated by BAPHIQ or PPD, will prepare a document for approval by DAFF, that describes the phytosanitary procedures for the pests of quarantine concern for Australia, and the various responsibilities of all parties involved in meeting this requirement.

Details of the operational system, or equivalent, will be determined by agreement between DAFF and BAPHIQ or PPD.

5.2.1 Registration of export orchards

The objective of this procedure is to ensure that fresh lychee fruit is sourced from registered export orchards producing export quality fruit, as the pest risk assessments are based on existing commercial production practices.

It is recommended that participating export orchards be registered before commencement of each harvest season. Taiwan and Vietnam should maintain a current list of registered orchards in order to facilitate trace-back of any consignment and make this available to DAFF on request.

5.2.2 Registration of packing houses and treatment facilities and auditing of procedures

The objectives of this procedure are to ensure that:

- fresh lychee fruit is packed only in registered packing sheds, processing export quality fruit, as the pest risk assessments are based on existing commercial packing procedures
- fresh lychee fruit is treated by a treatment provider/facility (if different to the packing facility) registered by Taiwan's BAPHIQ or Vietnam's PPD.
- references to the packing house/treatment provided (by registration number/reference code or packing house name) are clearly stated on cartons destined for export of fresh lychee fruit to Australia for trace-back and auditing purposes.

It is recommended that the packing houses and treatment providers be registered before the commencement of each harvest season. The registration list must be maintained as current by BAPHIQ or PPD in order to facilitate trace-back of any consignment.

Prior to the commencement of each export season, BAPHIQ and PPD, respectively, or other relevant authorised agency, should audit registered parking houses and treatment facilities, where fresh lychee fruit are packed, to ensure that the facilities are suitably equipped to meet Australia's import conditions. The audit should include registration requirements, packing house processes, product handling, product security, records and delivery of phytosanitary treatments. Records from these audits must be made available to DAFF on request.

5.2.3 Packaging and labelling

The objectives of this recommended procedure are to ensure that:

- fresh lychee fruit recommended for export to Australia and all associated packaging is not contaminated by quarantine pests or regulated articles (e.g. trash, soil and weed seeds)
- unprocessed packing material (which may vector pests not identified as being on the pathway) is not imported with fresh lychee fruit
- all wood material used in packaging of the commodity complies with DAFF conditions (see DAFF publication *Cargo Containers: Quarantine aspects and procedures*)
- secure packaging is used during storage and transport for export to Australia and must meet Australia's general import conditions for fresh fruits and vegetables at http://www.daff.gov.au/iconsearch.
- the packaged fresh lychee fruit is labelled with the orchard reference code (where appropriate) and the packing house/treatment facility reference or name for the purposes of trace-back. Additional stickers or stamping by NPPO may be required on individual cartons on irradiated fruit.
- the phytosanitary status of fruit must be clearly identified.

5.2.4 Storage and movement

The objectives of this recommended procedure are to ensure that:

- fresh lychee fruit for export to Australia that has been treated and/or inspected is kept secure and segregated at all times from any fruit for domestic or other markets or untreated product to prevent mixing or cross-contamination
- the quarantine integrity of the fresh lychee fruit during storage and movement is maintained.

5.2.5 Freedom from trash

All fresh lychee fruit must be free from trash. Freedom from trash will be confirmed during inspections. Consignments found to contain trash, or pests of quarantine concern to Australia should be withdrawn from export unless approved remedial action is available and applied to the export consignment.

5.2.6 Pre-export phytosanitary inspection and certification by BAPHIQ or PPD

The objectives of this recommended procedure are to ensure that:

- all consignments have been inspected in accordance with official procedures for all visually detectable quarantine pests at a standard sampling rate per phytosanitary certificate
- 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 orchard registration number or reference code and packing house details)
  - details of disinfestation treatments (e.g. VHT, irradiation or pre-shipment/in-transit cold treatment) which includes date, temperature, dose, duration, and/or treatment certificate (as appropriate)

  additional declaration statements as follows:
  - ‘*The fruit in this consignment has been produced in [Taiwan or Vietnam as appropriate] in accordance with the conditions governing entry of fresh lychee fruit to Australia and inspected and found free of quarantine pests*’ AND
  - another statement may be required, if irradiation is used for the treatment and live indentified pests are present within a consignment following treatment.

A consignment is the quantity of fresh lychee fruit covered by a single IPC that arrives at the destination. Consignments need to be shipped directly from one port or city in Taiwan or Vietnam to a designated port or city in Australia, or transhipped, in sealed containers.

5.2.7 On-arrival clearance and phytosanitary inspection by DAFF

The objectives of this recommended procedure are to ensure that:

- all consignments comply with Australian import requirements including treatment requirements as verified by DAFF on arrival
- consignments are as described on the phytosanitary certificate and quarantine integrity has been maintained.

To ensure that phytosanitary status of consignments of fresh lychee fruit from Taiwan or Vietnam meets Australia’s import conditions it is proposed that DAFF complete a verification inspection of all consignments of fresh lychee fruit. It is recommended that DAFF randomly sample 600 units from each consignment for quarantine pests.

5.2.8 Remedial action(s) for non-compliance

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

- any quarantine risk is addressed by remedial action, as appropriate
- non-compliance with import requirements is addressed, as appropriate.

5.3 Uncategorised pests

If an organism, including contaminant pests/pathogens, is detected on fresh lychee fruit either in Taiwan or Vietnam, or on-arrival in Australia that has not been categorised, it will require assessment by DAFF to determine its quarantine status and whether phytosanitary action is required.

5.4 Review of processes

5.4.1 Audit of protocol

Representatives from DAFF may audit the phytosanitary system in Taiwan and Vietnam.

5.4.2 Review of policy

DAFF reserves the right to review the import policy any time after trade commences.

Taiwan’s BAPHIQ or Vietnam’s PPD must inform DAFF immediately on detection in Taiwan or Vietnam, respectively, of any new pests of fresh lychee fruit that are of potential quarantine concern to Australia or of a significant change in the application of existing commercial practices considered in this report.

6 Conclusion

The findings of this draft report for the non-regulated analysis of existing policy for fresh lychee fruit from Taiwan and Vietnam are based on a comprehensive scientific analysis of relevant literature. DAFF 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 fresh lychee fruit from Taiwan and Vietnam.

Appendices

Appendix A Initiation and categorisation for pests of fresh lychee fruit from Taiwan and Vietnam[4]

Initiation (columns 1 – 3) identifies the pests associated with lychee production in Taiwan and Vietnam.

Pest categorisation (columns 4 - 8) identifies which of the pests are potential quarantine pests for the whole or part of Australia and have the potential to be on fresh lychee fruit produced in Taiwan and/or Vietnam and require a full pest risk assessment.

The steps in the categorisation processes are considered sequentially, with the assessment terminating at a 'Yes' for column 4 (except for pests of regional concern) and terminating at the first 'No' for columns 5, 6 or 7.

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

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Domain Eukarya							
Kingdom Animalia							
Phylum Arthropoda							
Class Arachnidia							
Order Prostigmata							
Acaspina litchii Huang, Huang & Horng [Prostigmata: Eriophyidae] Litchi rust mite	Yes (Hong and Zhang 1996)	No (Hong and Zhang 1996)	No (Halliday 2000)	No On leaves (Huang *et al.* 1990)	Assessment not required	Assessment not required	No

---

[4] 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 or have been deleted from the table, as they are not directly related to the export pathway of fresh lychee fruit and would be addressed by Australia's current approach to contaminating pests.

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Aceria litchii (Keifer) Synonym: *Eriophyes litchi* Keifer [Prostigmata: Eriophyidae] Litchi erinose mite, litchi gall mite	Yes (BAPHIQ 2004)	No (Hong and Zhang 1996)	Yes (Halliday 2000) Not in WA (Poole 2010)	Yes Eggs are laid on leaves, nymphs and adults feed on leaves and fruit (Waite and Hwang 2002).	Yes The confirmed host plant of *Aceria litchii* is lychees (Waite and Hwang 2002), although longan was previously reported as a host as well (Hong and Zhang 1996). The mite has established in Queensland and would be likely to establish and spread in Western Australia where lychees are grown.	No *Aceria litchii* is host specific to lychees. Western Australia has no significant lychee production (DAWA 2003).	No
Agistemus exsertus Gonzalez-Rodriguez [Prostigmata: Stigmaeidae] Stigmaeid mite	Yes (Tseng 1982)	No record found	No (Halliday 2000)	No *Agistemus exsertus* is a predatory mite (Tseng 1982), not likely to be on the export fruit pathway.	Assessment not required	Assessment not required	No
Brevipalpus phoenicis (Geijskes) [Prostigmata: Tenuipalpidae] Passionvine mite	Yes (CABI 2012)	Yes (PPD 2010)	Yes (Halliday 2000)	Assessment not required	Assessment not required	Assessment not required	No
Bryobia praetiosa Koch [Prostigmata: Tetranychidae] Clover mite	Yes (Migeon and Dorkeld 2012)	No (Migeon and Dorkeld 2012)	Yes (Halliday 2000)	Assessment not required	Assessment not required	Assessment not required	No
Oligonychus bicolor (Banks) [Prostigmata: Tetranychidae] Oak mite	Yes (Migeon and Dorkeld 2012)	No (Migeon and Dorkeld 2012)	No (Halliday 2000)	No On leaves (Jeppson *et al.* 1975)	Assessment not required	Assessment not required	No
Oligonychus biharensis Hirst [Prostigmata: Tetranychidae] Cassava red mite	Yes (Migeon and Dorkeld 2012)	No (Migeon and Dorkeld 2012)	Yes (Halliday 2000) Not in WA (Poole 2010)	No On leaves (Jeppson *et al.* 1975)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Oligonychus coffeae (Nietner) [Prostigmata: Tetranychidae] Tea red spider mite	Yes (Migeon and Dorkeld 2012)	Yes (PPD 2010)	Yes (Halliday 2000)	Assessment not required	Assessment not required	Assessment not required	No
Oligonychus litchii Lo & Ho [Prostigmata: Tetranychidae] Litchi spider mite	Yes (Migeon and Dorkeld 2012)	No (Migeon and Dorkeld 2012)	No (Halliday 2000)	No On leaves (Wen and Liou 2008)	Assessment not required	Assessment not required	No
Oligonychus mangiferus Rahman & Sapra, 1940 [Prostigmata: Tetranychidae] Mango spider mite	Yes (Migeon and Dorkeld 2012)	No (Migeon and Dorkeld 2012)	Yes (Halliday 2000)	Assessment not required	Assessment not required	Assessment not required	No
Orthotydeus kochi (Oudemans) [Prostigmata: Tydeidae] Tydeid mite	Yes (Zhang *et al.* 2010)	No record found	No (Halliday 2000)	No This species is known as a predator. It is associated with orange leaves in Italy (Vacante and Nucifora 1986).	Assessment not required	Assessment not required	No
Panonychus citri (McGregor) [Prostigmata: Tetranychidae] Citrus red mite	Yes (Migeon and Dorkeld 2012)	Yes (Migeon and Dorkeld 2012)	Yes (Halliday 2000) Not in WA (Poole 2010)	No This species is a major pest of citrus (CABI 2012) and has been reported as a minor pest of lychee (He 2001) but there are no records of presence on lychee fruit.	Assessment not required	Assessment not required	No
Polyphagotarsonemus latus (Banks) [Prostigmata: Tarsonemidae] Broad mite	Yes On lychee (PPD 2010) In Taiwan (Tseng and Lo 1980)	Yes (PPD 2010)	Yes (Halliday 2000)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Class Insecta							
Order: Blattodea							
Blattellidae: *Supella longipalpa* (Fabricius) Brown-banded cockroach	Yes On lychees (AQIS 2010) In Taiwan (Tsai *et al.* 2007)	No record found	Yes (CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No
Order Coleoptera							
Adoretus sinicus (Burmeister) [Coleoptera: Scarabaeidae] Chinese rose beetle	Yes On lychee (Tan 1998) In Taiwan (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	No (Cassis *et al.* 2002)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Anomala antiqua (Gyllenhal) [Coleoptera: Scarabaeidae] Groundnut shafer	No (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	Yes (Cassis *et al.* 2002)	Assessment not required	Assessment not required	Assessment not required	No
Anomala cupripes Hope [Coleoptera: Scarabaeidae] Large green shafer beetle	Yes On lychee (Tan 1998) In Taiwan (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	No (Cassis *et al.* 2002)	No Damage on leaves (Tan 1998; Wen and Liou 2008)	Assessment not required	Assessment not required	No
Anoplophora chinensis (Foester) As *Anoplophora macularia* Thomson in BAPHIQ (2004) [Coleoptera: Cerambycidae] Black and white citrus longhorn beetle	Yes (BAPHIQ 2004; CABI 2012)	Yes (CABI 2012)	No record found	No Damage on trunk (Tan 1998)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Aulacophora femoralis (Motschulsky) [Coleoptera: Chrysomelidae] Cucurbit leaf beetle	Yes On lychee (PPD 2010) In Taiwan (Kimoto 1966)	Yes (PPD 2010)	No (Reid 2008)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Aulacophora semifusca Jacoby Synonym: *Aulacophora almora* Maulik [Coleoptera: Chrysomelidae] Leaf beetle	Yes On lychees (Tan 1998) (as *Aulacophora almora*) In Taiwan (Kimoto 1989)	Yes On lychees (Tan 1998) (as *Aulacophora almora*) In Vietnam (Kimoto 1989)	No (Reid 2008)	No Damage on tender leaves and twigs (Tan 1998)	Assessment not required	Assessment not required	No
Cassida obtusata Boheman Synonym: *Tawania obtusata* [Coleoptera: Chrysomelidae] Leaf beetle	No (Borowiec and Swietojanska 2011)	Yes On lychee (Tan 1998) (as *Tawania obtusata*). In Vietnam (Borowiec and Swietojanska 2011)	No (Reid 2008)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Chrysochus chinesnsis Baly [Coleoptera: Chrysomelidae] Leaf beetle	Yes On lychees (Tan 1998) In Taiwan (Maki 1916)	No record found	No record found	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Euwallacea fornicatus (Eichhoff) [Coleoptera: Scolytidae] Shot-hole borer	Yes (CABI 2012)	Yes (PPD 2010)	Yes (CABI 2012) Not in WA (Poole 2010)	No The adult bores a tunnel into stems or branches (CABI 2012).	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Henosepilachna vigintioctopunctata (Fabricius) Synonym: *Epilachna vigintioctopunctata* (Fabricius) [Coleoptera: Coccniellidae] Hadda beetle, twentysix-spotted potato ladybird	Yes (CABI 2012)	Yes (CABI 2012)	Yes (Li 1993)	Assessment not required	Assessment not required	Assessment not required	No
Hypomeces squamosus (Fabricius) [Coleoptera: Curculionidae] Green weevil	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	No record found	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Phyllotreta striolata (Fabricius) [Coleoptera: Chrysomelidae] Cabbage flea beetle	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	No record found	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Protaetia orientalis Gory and Perchelon [Coleoptera: Scarabaeidae] Oriental flower beetle	Yes (Wen and Liou 2008)	No record found	No (Cassis *et al.* 2002)	No Although Wen and Liou (2008) listed this species as on fruit of lychees, the adults (17-20 mm) with white spots are easily visible and only chew on the surface of the fruit. Scarab larvae live in soil. It is unlikely that the species would be present on the export fruit pathway.	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Xylotrupes gideon (Linnaeus) [Coleoptera: Scarabaeidae] Elephant beetle, rhinoceros beetle	No (CABI 2012)	Yes (PPD 2010)	Yes (Cassis *et al.* 2002) Not in WA (Poole 2010)	No Although Tan *et al.* (1998) listed this species as damaging stem and fruit of lychee, the adults are large (>60 mm long) and easily visible. Adults only chew on the surface of the fruit. Larvae of scarabeid beetle live in soil. Note that *Xylotrupes gideon* was assesed as on the pathway in the IRA for longans and lychees from China and Thailand (DAFF 2004b). However, careful review of the biological information available as presented above concluded that it would be unlikely for the species to follow the export fruit pathway of lychees.	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Order Diptera							
Bactrocera cucurbitae Coquillet [Diptera: Tephritidae] Melon fruit fly	Yes (Wen 1985)	Yes On lychee (Wen 1985; Dhillon *et al.* 2005) Note PPD (2012a) stated that lychee is not a host of *B. cucurbitae* but it is clearly reported on lychees in Taiwan (Wen 1985). In Vietnam (CABI 2012; PPD 2012a).	No Not in mainland Australia but reported on Christmas Island and an occasional outbreak in the Torres Strait Protection Zone (CSIRO 2005). The reference for present in Australia by CABI (2012) relates to a few occurrences in the Torres Strait Islands.	Yes Eggs are laid below the skin of the fruit and larvae feed in fruit (CABI 2012).	Yes *Bactrocera cucurbitae* is polyphagous and feeds on many species of Cucurbitaceae and other families (CABI 2012). The species has been reported in Asia, Africa and Pacific islands. Both its host plants and suitable climatic conditions are available in mainland Australia for its establishment and spread.	Yes *Bactrocera cucurbitae* is a very serious pest of cucurbit crops throughout its native range of tropical Asia and in introduced areas such as the Hawaiian Islands. Damage levels can be anything up to 100% of unprotected fruit (CABI 2012).	Yes EP[5]
Bactrocera dorsalis (Hendel) [Diptera: Tephritidae] Oriental fruit fly	Yes (Drew and Hancock 1994; Wen and Liou 2008)	Yes (PPD 2010)	No record found	Yes Eggs are laid below the skin of the fruit and larvae feed in fruit (Wen and Liou 2008; CABI 2012).	Yes *Bactrocera dorsalis* is polyphagous, feeding on many host plants. The species has been reported widely in Asia (CABI 2012). The host plants and suitable climatic conditions are available in Australia for its establishment and spread.	Yes *Bactrocera dorsalis* is a very serious pest of a wide variety of fruits and vegetables throughout its range and damage levels can be anything up to 100% of unprotected fruit (CABI 2012).	Yes EP
Litchiomyia chinensis Yang and Luo [Diptera: Cecidomyiidae] Litchi gall midge	Yes (Hung *et al.* 2009)	No record found	No record found	No Larvae cause galls on leaves (Menzel 2002).	Assessment not required	Assessment not required	No

---

[5] The superscript 'EP' (existing policy) is used for pests that have previously been assessed and where policy already exists.

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Order Hemiptera							
Aleurocanthus woglumi Ashby [Hemiptera: Aleyrodidae] Citrus blackfly	Yes (CABI-EPPO 1997)	Yes (PPD 2010)	No record found	No Damage on leaves (CABI-EPPO 1997)	Assessment not required	Assessment not required	No
Andaspis hawaiiensis (Maskell) [Hemiptera: Diaspididae] Hawaiian scale	Yes (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	No On bark (Dekle 1965).	Assessment not required	Assessment not required	No
Aphis gossypii Glover [Hemiptera: Aphididae] Cotton aphid, melon aphid	Yes On lychee (PPD 2010) In Taiwan (Wang and Lin 1997; BAPHIQ 2012a)	Yes (PPD 2010)	Yes (Hollis and Eastop 2005)	Assessment not required	Assessment not required	Assessment not required	No
Aphis spiraecola Patch [Hemiptera: Aphididae] Spiraea aphid, apple aphid	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Hollis and Eastop 2005)	Assessment not required	Assessment not required	Assessment not required	No
Cantao ocellatus (Thunberg) [Hemiptera: Scutelleridae] Shield bug	Yes On lychee (PPD 2010) (BAPHIQ 2012a).	Yes (PPD 2010)	No (Cassis and Gross 2002)	No On leaves (Tan 1998)	Assessment not required	Assessment not required	No
Ceroplastes ceriferus (Fabricus) [Hemiptera: Coccidae] Indian white wax scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Ceroplastes floridensis Comstock [Hemiptera: Coccidae] Florida wax scale	Yes On lychee (PPD 2010) In Taiwan (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a) Not in WA (Poole 2010)	No Infestations of *C. floridensis* occur on the foliage, stems and branches (CABI 2012).	Assessment not required	Assessment not required	No
Ceroplastes pseudoceriferus Green [Hemiptera: Coccidae] Wax scale	Yes (Ben-Dov 2012a)	No (Ben-Dov 2012a)	No (Ben-Dov 2012a)	No Wax scales such as *C. floridensis* generally infest foliage, stems and branches of their host plants (CABI 2012). There is no record of *C. pseudoceriferus* on lychee fruit.	Assessment not required	Assessment not required	No
Ceroplastes rubens Maskell [Hemiptera: Coccidae] Pink wax scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No
Ceroplastes rusci L. [Hemiptera: Coccidae] Fig wax scale	No (Ben-Dov 2012a)	Yes (Ben-Dov 2012a)	No (Ben-Dov 2012a)	No Wax scales such as *C. floridensis* generally infest foliage, stems and branches of their host plants (CABI 2012). There is no record of *C. rusci* on lychee fruit.	Assessment not required	Assessment not required	No
Chrysomphalus aonidum (Linnaeus) Synonym: *C. ficus* Ashmead [Hemiptera: Diaspididae] Circular black scale, Florida red scale	Yes (Ben-Dov *et al.* 2012)	Yes (PPD 2010)	Yes (Ben-Dov *et al.* 2012)	Assessment not required	Assessment not required	Assessment not required	No
Cletus trigonus Thunberg [Hemiptera: Coreidae] Rice slender bug	Yes On lychee (Tan 1998) In Taiwan (DITARI 2011)	Yes On lychee (Tan 1998) In Vietnam (Tran 2010)	No record found	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Coccus hesperidum L. [Hemiptera: Coccidae] Soft brown scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No
Coccus longulus Douglas [Hemiptera: Coccidae] Long brown scale	Yes (Ben-Dov 2012a)	No (Ben-Dov 2012a)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No
Coccus viridis (Green) [Hemiptera: Coccidae] Green coffee scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No
Dysmicoccus lepelleyi (Betrem) [Hemiptera: Pseudococcidae] Lepelleyi mealybug	Yes (Williams 2004) Although Taiwan is not listed in the distribution for this species in Scalenet (Ben-Dov 2011), specimens of this mealybug from Taiwan on *Garcinia mangostana* were intercepted in the US (Williams 2004).	Yes (Williams 2004). Although PPD (2012a) noted that this species is absent from Vietnam, it has actually been intercepted on many host plants from Vietnam to Russia and USA (Williams 2004).	No (Ben-Dov 2011)	Yes *Dysmicoccus lepelleyi* was intercepted on lychees from Thailand to New York in 1972 (Williams 2004).	Yes *Dysmicoccus lepelleyi* has been reported on many host plants such as mango, citrus, coffee and lychee and from many countries in southeast Asia (Ben-Dov 2011). There are host plants available and climatic conditions suitable in Australia for its establishment and spread.	Yes Like other mealybug species, *D. lepelleyi* has the potential to become an important pest when introduced into new regions. For example, the cassava mealybug *Phenacoccus manihoti* Matile-Ferrerowas is a relatively minor nuisance in its native South America but after being inadvertently introduced to Africa in the early 1970s, it spread rapidly and devastated cassava fields and caused 65% yield losses of cassava tubers in the 1983 outbreak (Norgaard 1988).	Yes EP

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Dysmicoccus neobrevipes Beardsley [Hemiptera: Pseudococcidae] Gray pineapple mealybug	No (Ben-Dov 2011)	Yes (PPD 2010) Not on lychee (Ben-Dov 2011) Although PPD (2010) lists *D. neobrevipes* as on the lychee plant citing the Scalenet of 2007, *Litchi chinensis* is not actually included as a host of this species in the latest Scalenet (Ben-Dov 2011).	No (Ben-Dov 2011)	No On leaves (PPD 2010).	Assessment not required	Assessment not required	No
Empoasca vitis (Gothe) As *Empoasca flavescens* (Fabricius) in literature (CABI 2012) [Hemiptera: Cicadellidae] Smaller green leaf-hopper	No On lychee (Tan 1998) (As *Empoasca flavescens*) In Taiwan (CABI 2012)	Yes On lychee (Tan 1998) (As *Empoasca flavescens*) In Vietnam (CABI 2012)	No record found	No Damage on leaves and trunks (Tan 1998)	Assessment not required	Assessment not required	No
Erthesina fullo Thunberg [Hemiptera: Pentatomidae] Yellow spot stink bug	Yes (Wen and Liou 2008)	No record found	No (Cassis and Gross 2002)	No On leaves and flowers (Wen and Liou 2008)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Eucalymnatus tessellatus (Signoret) [Hemiptera: Coccidae] Tessallated scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a) No longer in WA (DAFWA 2012)	No On leaves and stems (Ben-Dov and Hodgson 1997)	Assessment not required	Assessment not required	No
Ferrisia virgata (Cockerell) [Hemiptera: Pseudococcidae] Striped mealybug	Yes (Ben-Dov 2011)	Yes (PPD 2010)	Yes (Ben-Dov 2011)	Assessment not required	Assessment not required	Assessment not required	No
Greenidea mangiferae [Hemiptera: Aphidae] Mango aphid	Yes (Wen and Liou 2008)	No record found	No (Hollis and Eastop 2005)	No On flowers and leaves (Wen and Liou 2008)	Assessment not required	Assessment not required	No
Hemiberlesia lataniae (Signoret) [Hemiptera: Diaspididae] Latania scale	Yes (Ben-Dov *et al.* 2012)	Yes (PPD 2010)	Yes (Ben-Dov *et al.* 2012)	Assessment not required	Assessment not required	Assessment not required	No
Hyperoncus lateritius (Westwood) Hemiptera: Pentatomidae] Shield bug	Yes On lychee (Tan 1998) In Taiwan (Yeh 2004)	No record found	No (Cassis and Gross 2002)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Ischnaspis longirostris (Signoret) [Hemiptera: Diaspididae] Black thread scale	Yes (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	Yes (Ben-Dov *et al.* 2012) Not in WA (Poole 2010)	Yes On leaves, stems and fruit (Tenbrink and Hara 1992)	Yes *Ischnaspis longirostris* has been reported on numerous host plants and from all over the world including eastern Australia (Ben-Dov *et al.* 2012). It is likely to establishment and spread in Western Australia if introduced.	Yes *Ischnaspis longirostris* is listed as a serious pest in many part of the world (Miller and Davidson 1990).	Yes EP, TW[6], WA[7]

---

[6] The superscript 'TW" is used to identify a species that has been reported in Taiwan but not in Vietnam.

[7] The superscript 'WA' (Western Australia) is used to identify pests that have not been recorded in Western Australia and are considered pests of concern for that state.

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Kerria lacca Kerr [Hemiptera: Kerriidae] Lac insect	Yes (BAPHIQ 2004)	No (Ben-Dov 2012b)	No (Ben-Dov 2012b)	No On stems (Wen and Liou 2008)	Assessment not required	Assessment not required	No
Kilifia acuminata (Signoret) [Hemiptera: Coccidae] Mango shield scale	Yes (Ben-Dov 2012a)	No (Ben-Dov 2012a)	No (Ben-Dov 2012a)	No This species was collected on leaves of mango (Bakr *et al.* 2009). No records on lychee fruit have been found.	Assessment not required	Assessment not required	No
Lawana imitata Melichar [Hemiptera: Flattidae] Flattid hopper	No (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	No record found	No Damage on branches and trunks (Tan 1998)	Assessment not required	Assessment not required	No
Leptocentrus albolineatus Funkhouser Hemiptera: Membracidae] Leaf hopper	Yes On lychee (Tan 1998) In Taiwan (Funkhouser 1943)	No record found	No (Fletcher and Watson 2009)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Leptocorisa acuta Thunberg [Hemiptera: Coreidae] Rice seed bug	Yes On lychee (Tan 1998) In Taiwan (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	Yes (Cassis and Gross 2002)	Assessment not required	Assessment not required	Assessment not required	No
Leptoglossus gonagra (Fabricius) [Hemiptera: Coreidae] Passionvine bug	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Cassis and Gross 2002)	Assessment not required	Assessment not required	Assessment not required	No
Nezara viridula (Linneus) [Hemiptera: Pentatomidae] Green vegetable bug	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Cassis and Gross 2002)	Assessment not required	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Nipaecoccus viridis (Newstead) Synonym: *Nipaecoccus vastator* (Maskell) [Hemiptera: Pseudococcidae] Spherical mealybug	Yes (Ben-Dov 2011)	Yes (PPD 2010)	Yes (Ben-Dov 2011)	Assessment not required	Assessment not required	Assessment not required	No
Paracoccus interceptus Lit Synonym: *Planococcus morrisoni* Ezzat & Mconnell [Hemiptera: Pseudococcidae] Intercepted mealybug	No (Ben-Dov 2011)	Yes (PPD 2010)	No (Ben-Dov 2011)	Yes On fruit (PPD 2010)	Yes *Paracoccus interceptus* has been reported on many host plants and from Benin in Africa and many countries in Asia (Ben-Dov 2011). It is likely to establish and spread in Australia if introduced.	Yes Like other mealybug species, *P. interceptus* has the potential to become an important pest when introduced into new regions.	Yes
Parasaissetia nigra (Nieter) [Hemiptera: Coccidae] Nigra scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No
Parlatoria cinerea Danne & Hadden Synonym: *Parlatoria pseudopyri* Kuwana [Hemiptera: Diaspididae] Tropical grey chaff scale	Yes (Ben-Dov *et al.* 2012)	Yes (PPD 2010)	No (Ben-Dov *et al.* 2012)	Yes On leaves, bark, twigs, branches, trunk and fruit (PPD 2010)	Yes *Parlatoria cinerea* has been reported on many host plants and from many countries in Africa, North and South America and Asia (Ben-Dov *et al.* 2012). It is likely to establish and spread in Australia if introduced.	Yes *Parlatoria cinerea* is included in “A list of the armoured scale insect pests” as an occasional pest (Miller and Davidson 1990).	Yes EP
Pinnaspis strachani (Cooley) [Hemiptera: Diaspididae] Cotton white scale	Yes (Ben-Dov *et al.* 2012)	Yes (PPD 2010)	Yes (Ben-Dov *et al.* 2012)	Assessment not required	Assessment not required	Assessment not required	No
Planococcus citri (Risso) [Hemiptera: Pseudococcidae] Citrus mealybug	Yes (BAPHIQ 2004)	Yes (PPD 2010)	Yes (Ben-Dov 2011)	Assessment not required	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Planococcus lilacinus (Cockerell) [Hemiptera: Pseudococcidae] Coffee mealybug	Yes (Ben-Dov 2011)	Yes (Ben-Dov 2011)	No (Ben-Dov 2011) Although detected in the Torres Strait Islands in 2010, there are quarantine measures in place to prevent its spread into mainland Australia, one of the important roles played by the Northern Australia Quarantine Strategy (NAQS 2012).	Yes Infests young shoots and fruits of *Litchi chinensis* (Ghose 1961). It was intercepted on *Litchi* sp. from Vietnam in Australia (Williams 2004).	Yes *Planococcus lilacinus* has been reported on many host plants and from many countries in Asia (Ben-Dov 2011). It is likely to establish and spread in Australia if introduced.	Yes *Planococcus lilacinus* is common in Southern Asia and has been reported attacking many economically important crops such as coffee, cocoa, and lychees (Williams 2004). It is also known to transmit Ceylon cocoa virus in parts of Sri Lanka (Williams 2004).	Yes ^{EP}
Planococcus litchi Cox [Hemiptera: Pseudococcidae] Litchi mealybug	No (Ben-Dov 2011)	Yes (PPD 2010)	No (Ben-Dov 2011)	Yes (USDA 2005) Although PPD (2010) listed *Planococcus litchi* as on leaves of lychees, this species was assessed as on the pathway in the IRA on longans and lychees from China and Thailand (DAFF 2004b) and listed as on fruit of lychees by USDA (2005).	Yes *Planococcus litchi* has been reported on several host plants including lychees and longans and from several countries in Asia (Ben-Dov 2011). It is likely to establish and spread in Australia if introduced.	Yes Like other mealybug species, *P. litchi* has the potential to become an important pest when introduced into new regions.	Yes $^{EP, VN}$[8]
Planococcus minor (Maskell) [Hemiptera: Pseudococcidae] Passionvine mealybug	Yes On lychee (USDA 2011) In Taiwan (Ben-Dov 2011)	Yes (Williams 2004; USDA 2011).	Yes (Ben-Dov 2011) Not in WA (Poole 2010)	Yes, *Planococcus minor* is found on fruit of durian, rambutan, banana and citrus (CISEH 2012) and it is likely to infest fresh lychee fruit.	Yes *Planococcus minor* has been reported on numerous host plants and from many countries in the world (Ben-Dov 2011). It is likely to establish and spread in Western Australia if introduced.	Yes *Planococcus minor* is a common pest of many economically important plants, particularly cocoa, throughout its geographical range (Ben-Dov 2011).	Yes $^{WA, EP}$

---

[8] The superscript “VN” is used to identify a species that has been reported in Vietnam but not in Taiwan.

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Prococcus acutissimus (Green) [Hemiptera: Coccidae] Banana-shaped scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	No (Ben-Dov 2012a)	No On leaves (PPD 2010)	Assessment not required	Assessment not required	No
Pseudaonidia trilobitiformis (Green) [Hemiptera: Diaspididae] Cashew scale	Yes (Ben-Dov *et al.* 2012)	Yes (PPD 2010)	Yes (Ben-Dov *et al.* 2012) Not in WA (Poole 2010)	No On bark, stems and leaves (PPD 2010)	Assessment not required	Assessment not required	No
Pseudaulacaspis cockerelli (Cooley) Synonym: *Phenacaspis cockerelli* (Cooley) [Hemiptera: Diaspididae] False oleander scale, false mango scale	Yes (Ben-Dov *et al.* 2012)	Yes (PPD 2010)	Yes (Ben-Dov *et al.* 2012)	Assessment not required	Assessment not required	Assessment not required	No
Pseudococcus baliteus Lit in Lit & Calilung [Hemiptera: Pseudococcidae] Aerial root mealybug	No (Ben-Dov 2011)	Yes (PPD 2010)	No (Ben-Dov 2011)	No On roots (PPD 2010)	Assessment not required	Assessment not required	No
Pseudococcus comstocki (Kuwana) [Hemiptera: Pseudococcidae] Comstock's mealybug	No (Ben-Dov 2011)	Yes (PPD 2010)	No (Ben-Dov 2011)	No On foliage of lychee (Hill 1983)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Pseudococcus cryptus Hempel Synonym: *P. citriculus* Green [Hemiptera: Pseudococcidae] Citriculus mealybug	Yes (Ben-Dov 2011)	Yes (PPD 2010)	No (Ben-Dov 2011) Although detected at the tip of Cape York Peninsula in 2011, there are quarantine measures in place to prevent its spread to other parts of Australia, one of the important roles played by the Northern Australia Quarantine Strategy (NAQS 2012).	Yes Roots, leaves, shoots and fruit (PPD 2010)	Yes *Pseudococcus cryptus* has a wide host range including mango, citrus, grapes as well as lychees and is reported from Africa, Asia, and South America (Ben-Dov 2011). It is likely to establish and spread in Australia if introduced.	Yes *Pseudococcus cryptus* is a pest of many economically important host plants such as citrus, mango and grapes (Ben-Dov 2011).	Yes ^{EP}
Pseudococcus jackbeardsleyi Gimpel & Miller [Hemiptera: Pseudococcidae] Jack Beardsley mealybug	Yes (Ben-Dov 2011)	Yes (PPD 2010)	No (Ben-Dov 2011) Although detected in the Torres Strait Islands in 2010, there are quarantine operation measures in place to prevent its spread into mainland Australia, one of the important roles played by the Northern Australia Quarantine Strategy (NAQS 2012).	Yes Occurring primarily on the leaves, stems, and fruit of the host (CABI 2012).	Yes *Pseudococcus jackbeardsleyi* has been recorded from numerous hosts and is reported from Africa, Asia, Pacific islands, and North, Central and South America (Ben-Dov 2011). It is likely to establish and spread in Australia if introduced.	Yes *Pseudococcus jackbeardsleyi* occurs on many fruit, vegetable and ornamental hosts and has the potential to become an important pest (CABI 2012).	Yes ^{EP}

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Pulvinaria psidii Maskell Synonym: *Chloropulvinaria psidii* (Maskell) [Hemiptera: Coccidae] Green shield scale	Yes (BAPHIQ 2004)	No (Ben-Dov 2012a)	Yes (Ben-Dov 2012a)	No On leaves and stems (Wen and Liou 2008)	Assessment not required	Assessment not required	No
Pyrops candelaria *Linnaeus* Synonym: *Fulgora condelaria* Linnaeus; *Laternaria candalaria* (Linnaeus) [Hemiptera: Fulgoridae] Lantern bug, longan leafhopper	Yes On lychee (Tan 1998) (as *Fulgora condelaria L.)* In Taiwan (Chen *et al.* 2008)	Yes On lychee (Tan 1998) (as *Fulgora condelaria L.)* In Vietnam (Chen *et al.* 2008)	No (Fletcher and Watson 2009)	No Damage on trunks (Tan 1998)	Assessment not required	Assessment not required	No
Ricania speculum (Walker) [Hemiptera: Ricaniidae] Black leafhopper	Yes On lychee (Tan 1998) In Taiwan (CABI 2012)	No (CABI 2012)	No (Fletcher and Watson 2009)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Riptortus linearis Fabricius [Hemiptera: Alydidae] Legume pod bug	Yes On lychee (Tan 1998) In Taiwan (CABI 2012)	No (CABI 2012)	Yes (Cassis and Gross 2002) Not in WA (Poole 2010)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Rutherfordia major (Cockerell) [Hemiptera: Diaspididae] Litchi bark scale	Yes (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	No On bark (Dekle 1976)	Assessment not required	Assessment not required	No
Saissetia coffeae (Walker) [Hemiptera: Coccidae] Hemispherical scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Saissetia oleae (Olivier) [Hemiptera: Coccidae] Black scale	Yes (Ben-Dov 2012a)	Yes (PPD 2010)	Yes (Ben-Dov 2012a)	Assessment not required	Assessment not required	Assessment not required	No
Selenaspidus articulatus (Morgan) [Hemiptera: Diaspididae] West Indian red scale	Yes (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	Yes (Ben-Dov *et al.* 2012) Not in WA (Poole 2010)	Yes On bark, fruit and leaves (Dekle 1976)	Yes *Selenaspidus articulatus* has been reported from numerous host plants including many economically important crops such as citrus, ficus, cocoa as well as lychee, and from Africa, North and South America, Asia and the Pacific as well as eastern Australia (Ben-Dov *et al.* 2012). It is likely to establish and spread in Western Australia if introduced.	Yes *Selenaspidus articulatus* is listed as a serious pest in many part of the world (Miller and Davidson 1990).	Yes $^{EP, TW, WA}$
Solenostethium chinense Stål [Hemiptera: Scutelleridae] Yellow-belly arctiid, shield backed bug	Yes On lychee (Tan 1998) In Taiwan (Esaki 1926)	No (CABI 2012)	No (Cassis and Gross 2002)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Tessaratoma papillosa (Drury) [Hemiptera: Pentatomidae] Litchi stink bug	Yes (CABI 2012)	Yes (PPD 2010)	No (Cassis and Gross 2002)	No Adults and nymphs feed on the terminals, flowers, twigs and fruit and usually cause premature drop of fruit (Tan 1998; Waite and Hwang 2002; PPD 2012a). It is considered that the insects will not likely follow the export fruit pathway because adults (up to 28 mm long) and nymphs (up to 20 mm long) would leave the fruit by flying away or dropping to the ground when disturbed during harvesting and are highly visible. Note that *Tessaratoma papillosa* was assessed as on the pathway in the IRA for lychees from China and Thailand and the likelihood of importation was rated as ‘very low’ and unrestricted risk estimate as ‘negligible’ (DAFF 2004b).	Assessment not required	Assessment not required	No
Thysanofiorinia leei Williams [Hemiptera: Diaspididae] Hard scale	Yes (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	No The biology of *Thysanofiorinia leei* is most likely similar to that of *T. nephelii* which is found on leaves and stems of lychees (Mossler 2009).	Assessment not required	Assessment not required	No
Thysanofiorinia nephelii Maskell [Hemiptera: Diaspididae] Hard scale	Yes (Ben-Dov *et al.* 2012)	No (Ben-Dov *et al.* 2012)	Yes (Ben-Dov *et al.* 2012) Not in WA (Poole 2010)	No Symptoms of scale infestation on lychees include leaf chlorosis, leaf abscission, dieback of stems and limbs, and sooty mould on the surfaces of leaves and stems (Mossler 2009).	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Toxoptera aurantii (Boyer de Fonsolombe) [Hemiptera: Aphididae] Black citrus aphid	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Hollis and Eastop 2005)	Assessment not required	Assessment not required	Assessment not required	No
Order Hymenoptera							
Oecophylla smaragdina (Fabricius) [Hymenoptera: Formicidae] Green tree ant	No record found	Yes (PPD 2010)	Yes (Shattuck 2008)	Assessment not required	Assessment not required	Assessment not required	No
Order Isoptera							
Odontotermes formosanus Shiraki [Isoptera: Termitidae] Black-winged subterranean termite	Yes On lychee (Li *et al.* 1997) In Taiwan (CABI 2012)	Yes On lychee (Li *et al.* 1997) In Vietnam (CABI 2012)	No record found	No On trunks (Wen and Liou 2008)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Order Lepidoptera							
Achaea janata (Linnaeus) [Lepidoptera: Noctuidae] Caster oil looper	No (CABI 2012)	Yes (PPD 2010)	yes (Nielsen *et al.* 1996)	Assessment not required	Assessment not required	Assessment not required	No
Adoxophyes orana (Fischer von Röeslerstamm) [Lepidoptera: Tortricidae] Summer fruit tortrix moth	Yes On lychee (Huang *et al.* 1997) In Taiwan (Razowski 2000)	No (CABI 2012)	No (Nielsen *et al.* 1996)	Yes Typically, *A. orana* spins a leaf against a fruit. The larva is often found in between those two plant organs and fruit damage is mostly found at the spots where such a leaf is attached to the fruit (CABI 2012).	Yes *Adoxophyes orana* is a polyphagous species that feeds on more than 50 different plant species from multiple families, such as apple, apricot, plum, cherry and other fruit crops (CABI 2012). Host plants of *A. orana* are distributed commonly and widely throughout Australia. *Adoxophyes orana* is known to have established and spread outside its native range in areas where it has been introduced, for example, Greece and Britain (Carter 1984; Milonas and Savopoulou-Soultani 2004).	Yes *Adoxophyes orana* is a major pest of fruit tree crops in China and elsewhere in the world. It has been reported to cause up to 50% crop loss over large areas (Davis *et al.* 2005). The polyphagous nature of *A. orana* indicates the potential for consequences across a wide range of fruit growing industries, as well as for wild plants.	Yes $^{EP, TW}$
Adoxophyes privatana (Walker) [Lepidoptera: Tortricidae] Tortricid moth	Yes (Hung *et al.* 2006)	Yes On lychee (Hung *et al.* 2006) In Vietnam (CABI 2012)	No (Nielsen *et al.* 1996)	No On young shoots (Hung *et al.* 2006)	Assessment not required	Assessment not required	No
Archips machlopis (Meyrick) [Lepidoptera: Tortricidae] Leaf roller	No (Meijerman and Ulenberg 2011)	Yes (Meijerman and Ulenberg 2011)	No (Nielsen *et al.* 1996)	No Larvae are polyphagous and generally roll or tie leaves, but may also occur in shoots or seed pods (Meijerman and Ulenberg 2011).	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Archips micaceana (Walker) [Lepidoptera: Tortricidae] Leaf roller	No (CABI 2012)	Yes (PPD 2010)	No (Horak 2006)	No On leaves and flowers (PPD 2010)	Assessment not required	Assessment not required	No
Attacus atlas (Linnaeus) [Lepidoptera: Saturniidae] Atlas moth	Yes (CABI 2012)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	No On leaves (PPD 2010)	Assessment not required	Assessment not required	No
Cephonodes hylas Linnaeus [Lepidoptera: Sphingidae] Coffee hawk moth	Yes On lychee (Kuroko and Lewvanich 1993) In Taiwan (CABI 2012)	Yes On lychee (Kuroko and Lewvanich 1993) In Vietnam (CABI 2012)	Yes (Nielsen *et al.* 1996)	Assessment not required	Assessment not required	Assessment not required	No
Cerace stipatana Walker [Lepidoptera: Tortricidae] Tortrix moth	Yes On lychee (Huang *et al.* 1997) In Taiwan (Heppner and Bae 2010)	No record found	No (Nielsen *et al.* 1996)	No On leaves (AQSIQ 2003a)	Assessment not required	Assessment not required	No
Chalioides kondonis Matsumura [Lepidoptera: Psychidae] Kondo white psychid	Yes On lychee (Tan 1998) In Taiwan (Seino 1980)	No record found	No (Nielsen *et al.* 1996)	No Damage on trunks (Tan 1998)	Assessment not required	Assessment not required	No
Conogethes evaxalis (Walker) [Lepidoptera: Pyralidae] Pyralid moth	Yes (Hung *et al.* 2006)	No record found	No (Nielsen *et al.* 1996)	No On young shoots (Hung *et al.* 2006)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Conogethes punctiferalis (Guenée) Synonym: *Dichocrocis puntiferalis* Guenée) [Lepidoptera: Pyralidae] Yellow peach moth	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Nielsen *et al.* 1996)	Assessment not required	Assessment not required	Assessment not required	No
Conopomorpha cramerella (Snellen, 1904) [Lepidoptera: Gracillariidae] Cocoa pod borer	Yes On lychee (Robinson *et al.* 2010) In Taiwan (de Prins and de Prins 2011)	Yes On lychee (Robinson *et al.* 2010) In Vietnam (de Prins and de Prins 2011)	No Reported in NT in 1910 but never found again. Record of Australia in Herbison-Evans and Crossley (2005) likely refers to the NT record. Detected in Port Douglas, Qld in 2011 and under eradication (DEEDI 2011).	No Lychee was listed as a host of *Conopomorpha cramerella* in the database of the world's lepidopteran host plants by Robinson *et al.* (2010), but this may be based on early confused records. It has been clarified by Bradley (1986) that the species of *Conopomorpha* found on lychees are *C. sinensis* and *C. litchiella* and not *C. cramerella* which is commonly found on ramutan and cocoa. In addition, extensive three years (1991-1994) target survey of species of *Conopomorpha* only found *C. sinensis* and ocassionally *C. litchiella* on lychees in Taiwan (Hung *et al.* 2006). .	Assessment not required	Assessment not required.	No
Conopomorpha litchiella Bradley [Lepidoptera: Gracillariidae] Litchi leaf miner	Yes (Hwang and Hung 1996)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	No On leaves (Wen and Liou 2008)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Conopomorpha sinensis Bradley [Lepidoptera: Gracillariidae] Litchi fruit borer	Yes (BAPHIQ 2004)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	Yes Damage on tender leaves, twigs, flowers and fruit (Tan 1998; Hung *et al.* 2006; Wen and Liou 2008)	Yes Host plants of *Conopomorpha sinensis* include longans, lychees and cocoa. It has been reported from mainland China, India, Nepal, Thailand and Vietnam as well as Taiwan (Waite and Hwang 2002). Host plants are available and climatic conditions suitable in Australia for its establishment and spread if introduced.	Yes *Conopomorpha sinensis* is a major economic pest of longans and lychees in mainland China, Taiwan and Thailand (Waite and Hwang 2002).	Yes EP
Cricula trifenestrata (Helfer) [Lepidoptera: Saturniidae] Cricula silkmoth	No (CABI 2012)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	No On leaves PPD 2010	Assessment not required	Assessment not required	No
Cryptophlebia ombrodelta (Lower) [Lepidoptera: Tortricidae] Macadamia nutborer	Yes (CABI 2012)	Yes (PPD 2010)	Yes (Horak 2006)	Assessment not required	Assessment not required	Assessment not required	No
Cryptothelea variegata Snellen [Lepidoptera: Psychidae] Bagworm	No (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	No (Nielsen *et al.* 1996)	No Damage on trunks (Tan 1998)	Assessment not required	Assessment not required	No
Dasychira mendosa Hübner Synonym: *Olene mendosa* Hübner [Lepidoptera: Lymantriidae] Brown tussock moth	Yes (Wen *et al.* 1991)	Yes (PPD 2010)	Yes (Nielsen *et al.* 1996) Not in WA (Poole 2010)	No On leaves (PPD 2010)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Deudorix epijarbas (Moore) Synonym: *Deudorix epijarbas amatius* Fruhstorfer [Lepidoptera: Lycaenidae] Pomegranate butterfly, cornelian	Yes (Wen and Liou 2008)	No (PPD 2012a)	Yes (Nielsen *et al.* 1996) Not in WA (Poole 2010)	No *Deudorix epijarbas* is reported on fruit of lychee (Tan 1998; Waite and Hwang 2002; Wen and Liou 2008) but the attack is only occasional on young lychee fruit (AQSIQ 2003b) Infestation can result in rotting of fruit or premature fruit drop. Female lays eggs singly on the fruit and, after hatching, the larva bores inside the fruit and completely destroys the flesh and seed. The larva can move from fruit to fruit, damaging three or four in the process. The larva chews a neat round hole in the skin of the fruit and plugs the hole with its flattened rear end, as it feeds inside (Waite and Hwang 2002). Note that *Deudorix epijarbas* was assessed as on the pathway in the IRA for longans and lychees from China and Thailand (DAFF 2004b). However, considering that the species only occasionally attacks young lychee fruit, the damaged fruit either rot or drop prematurely, or show clear signs of damage, *D. epijarbas* is unlikely to follow the export lychee pathway.	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Dude parabola Meyrick Synonym: *Platypeplus aprobola* Meyrick, *Argyroploce aprobola* Meyrick [Lepidoptera: Tortricidae] Brown tortrix	Yes (Hung *et al.* 2006)	Yes (PPD 2010)	Yes (Horak 2006) Not in WA (Poole 2010)	No On young shoots (Hung *et al.* 2006)	Assessment not required	Assessment not required	No
Dudusa synopla Swinhoe [Lepidoptera: Notodontidae] Leaf-eating caterpillar	Yes On lychee (Kuroko and Lewvanich 1993) In Taiwan (Anonymous 2011b)	Yes On lychee (Kuroko and Lewvanich 1993) In Vietnam (Anonymous 2011b)	No (Nielsen *et al.* 1996)	No On leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Eboda celligera Meyrick [Lepidoptera: Tortricidae] Tortricid moth	Yes (Hung *et al.* 2006)	No record found	No (Nielsen *et al.* 1996)	No Although *Thalassodes immissarius* causes damage on tender leaves, shoots, flowers and fruit (Tan 1998; Hung *et al.* 2006) and is listed as collected from flowers and fruit in Figure 4 by Hung *et al.* (2006), careful examination of the article by Hung *et al.* (2006) indicates that the insects were only found in April during lychee flowering and fruit development stage and not after May when the fruit are maturing. Thus it is unlikely to be on the export pathway. Note that *Eboda celligera* was also assessed as not on the pathway by DAFF for longans and lychees from China and Thailand (DAFF 2004b).	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Eucosma notanthes Meyrick As *Cydia notanthes* (Meyrick) in Hung *et al.* (2006) [Lepidoptera: Totricidae] Carambola fruit borer	Yes (Hung *et al.* 2006)	No record found	No (Nielsen *et al.* 1996)	No *Eucosma notanthes* is an important pest of carambola (CUT 2012). Because the adults of this species were caught in sex pheromone traps around lychee orchards, Hung *et al.* (2006) carried out experiments to determine if lychee is a host for this pest. The results indicate that no *Eucosma notanthes* was collected from young shoots and fruit of lychees in the orchards, but rearing experiments in the laboratory and in bags on the trees showed this species can complete its life cycle development feeding on lychee although the survival rate is low.	Assessment not required	Assessment not required	No
Eudocima fullonia (Clerck) Synonym: *Othreis fullonia* Clerck, *O. fullonica* Linn. [Lepidoptera: Noctuidae] Fruit-piercing moth	Yes (CABI 2012)	Yes (PPD 2010)	Yes (Nielsen *et al.* 1996)	Assessment not required	Assessment not required	Assessment not required	No
Eudocima salaminia (Cramer) [Lepidoptera: Noctuidae] Fruit-piercing moth	Yes On lychee (PPD 2010) In Taiwan (Kluesener 1994)	Yes (PPD 2010)	Yes (Nielsen *et al.* 1996) Not in WA (Poole 2010)	No A fruit-piercing moth possesses a strong, armoured proboscis with which it penetrates the skin or rind of fruit to feed on the juice. These large moths only feed at night and particularly the first few hours after sundown (Fay 2005). Larvae feed on leaves where eggs are laid. It is unlikely that the moth will be on the export fruit pathway.	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Euproctis scintillans (Walker) [Lepidoptera: Lymantriidae] Hairy tussock caterpillar	No (CABI 2012)	Yes On lychee (Tan 1998) (as *Porthesia scintillans*) In Vietnam (CABI 2012)	No (Nielsen *et al.* 1996)	No *Euproctis scintillans* damages young shoots, leaves, flowers and fruit (Tan 1998; AQSIQ 2003a). However, the larvae only chew on newly formed young fruit (AQSIQ 2003a) and it is unlikely that they will follow the export pathway on mature fruit. It was also assessed as not associated with the export pathway in longans and lychees from China and Thailand (DAFF 2004b).	Assessment not required	Assessment not required	No
Euproctis varians (Walker) [Lepidoptera: Lymantriidae] Moth/caterpillar	Yes On lychee (Tan 1998) In Taiwan (Bigger 2009a)	No record found	No (Nielsen *et al.* 1996)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Homona coffearia (Neither) [Lepidoptera: Tortricidae] Tea flushworm	Yes (CIE 1974)	Yes (CIE 1974)	No (Nielsen *et al.* 1996)	No Leaf feeder (Bigger 2009b)	Assessment not required	Assessment not required	No
Homona spargotis Meyrick As *Homona coffearia* (Nietner) in PPD (2010) [Lepidoptera: Tortricidae] Avocado leafroller	No record found	Yes (PPD 2010)	Yes (Nielsen *et al.* 1996) Not in WA (Poole 2010)	No On leaves and flowers (PPD 2010)	Assessment not required	Assessment not required	No
Indarbela dea (Swinhoe) Synonym: *Lepidarbela dea* Swinhoe [Lepidoptera: Cossidae] Cossid moth	No (CABI 2012)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	No On bark and wood (PPD 2010)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Larentiinae [Lepidoptera: Geometridae] Geometrid moth	Yes (Hung *et al.* 2006)	Uncertain	Uncertain	No On lychee shoots (Hung *et al.* 2006)	Assessment not required	Assessment not required	No
Lobesi sp. [Lepidoptera: Tortricidae] Tortricid moth	Yes (Hung *et al.* 2006)	Uncertain	Uncertain	No *Lobesi* sp. was collected on young shoots of lychees and longans (Hung *et al.* 2006).	Assessment not required	Assessment not required	No
Lymantria dispar Linnaeus [Lepidoptera: Lymantriidae] Asian gypsy moth	Yes (CABI 2012) Note BAPHIQ ((2012a) indicates this species has not been reported from Taiwan.	No (CABI 2012)	No (Nielsen *et al.* 1996)	No Feeds on flushing buds and later on leaves and flowers (CABI 2012). No records can be found of the eggs or larvae of this species on lychee fruit.	Assessment not required	Assessment not required	No
Lymantria mathura More [Lepidoptera: Lymantriidae] Rosy gypsy moth	Yes (CABI 2012)	No (CABI 2012)	No (Nielsen *et al.* 1996)	No On flowers and leaves (CABI 2012)	Assessment not required	Assessment not required	No
Lymantria xylina [Lepidoptera: Lymantriidae] Casuarina moth	Yes (Chao *et al.* 1996) (BAPHIQ 2012a)	No record found	No (Nielsen *et al.* 1996)	No Defoliation of fruit trees (Chao *et al.* 1996)	Assessment not required	Assessment not required	No
Miresa fulgida Wilemam [Lepidoptera: Limacodidae] Slug caterpillar	Yes On lychee (He 2001) In Taiwan (Wu and Solovyev 2011)	Yes On lychee (He 2001) In Vietnam (Wu and Solovyev 2011)	No (Nielsen *et al.* 1996)	No Larvae of *Miresa* feed on leaves of host plants (Wu and Solovyev 2011).	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Orgyia postica (Walker) Synonym: *Notolophus australis posticus* Walker Lepidoptera: Lymantriidae] Cocoa tussock moth	Yes (BAPHIQ 2004)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	No Damage on leaves and flowers (Tan 1998; Wen and Liou 2008)	Assessment not required	Assessment not required	No
Orgyia turbata Butler [Lepidoptera: Lymantriidae] Tussock moth	No (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	No (Nielsen *et al.* 1996)	No Damage on leaves (Tan 1998)	Assessment not required	Assessment not required	No
Oxyodes scrobiculata (Fabricius) [Lepidoptera: Noctuidae] Noctuid moth	Yes (Hung *et al.* 2006)	No record found	Yes (Nielsen *et al.* 1996) Not in WA (Poole 2010)	No Damage on tender leaves and twigs (Tan 1998)	Assessment not required	Assessment not required	No
Parasa lepida (Cramer) [Lepidoptera: Limacodidae] Nettle caterpillar	No (CABI 2012)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	No On leaves (PPD 2010)	Assessment not required	Assessment not required	No
Pingasa nagniuia Guenue [Lepidoptera: Geometridae] Geometrid moth	Yes (Wen and Liou 2008)	No record found	No (Nielsen *et al.* 1996)	No On leaves (Wen and Liou 2008)	Assessment not required	Assessment not required	No
Pingasa ruginaria Guenée [Lepidoptera: Geometridae] Flower-eating caterpillar	Yes On lychee (Kuroko and Lewvanich 1993) In Taiwan (Inoue 1964)	No record found	No (Nielsen *et al.* 1996)	No On flowers and young leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Polydesma boarmoides Guenée [Lepidoptera: Noctuidae] Noctuid moth	Yes On lychee (Kuroko and Lewvanich 1993) In Taiwan (Chao 2011)	No record found	Yes (Nielsen *et al.* 1996) Not in WA (Poole 2010)	No On leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Porthesia taiwana [Lepidoptera: Lymantriidae] Taiwan tussock moth	Yes (BAPHIQ 2004)	No record found	No (Nielsen *et al.* 1996)	No On leaves and flowers (Wen and Liou 2008)	Assessment not required	Assessment not required	No
Pseudonirmides cyanopasta Hampson [Lepidoptera: Limacodidae] Leaf-eating caterpillar	No record found	Yes On lychee (Kuroko and Lewvanich 1993) In Vietnam (Solovyev and Witt 2009)	No (Nielsen *et al.* 1996)	No On leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Rapala pheretima petosiris Hewitson [Lepidoptera: Lycaenidae] Lycaenid moth	No (Inayoshi 2011a)	Yes On lychee (Kuroko and Lewvanich 1993) In Vietnam (Inayoshi 2011a)	No (Nielsen *et al.* 1996)	No On flowers (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Rapala varuna orseris Hewitson [Lepidoptera: Lycaenidae] Lycaenid moth	No (Inayoshi 2011b)	Yes On lychee (Kuroko and Lewvanich 1993) In Vietnam (Inayoshi 2011b)	No (Nielsen *et al.* 1996)	No On flowers and young leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Spodoptera litura (Fabricus) Synonym: *Prodenia litura* Fabricus [Lepidoptera: Noctuidae] Cluster caterpillar	Yes On lychee (Tan 1998) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Nielsen *et al.* 1996)	Assessment not required	Assessment not required	Assessment not required	No
Statherotis discana (Felder & Rogenhofer) [Lepidoptera: Tortricidae] Litchi leaf roller	Yes (CABI 2012)	Yes (PPD 2010)	No (Horak 2006)	No On leaves (PPD 2010)	Assessment not required	Assessment not required	No
Statherotis leucaspis Meyrick Synomym: *Olethreates leucaspis* Meyrick [Lepidoptera: Tortricidae] Leaf roller	Yes (Hung *et al.* 2006)	No (PPD 2012a)	No (Horak 2006)	No *Statherotis leucaspis* is essentially a leaf feeder (Wen and Liou 2008), although it can also cause damage on lychee shoots, flowers and fruit (Hung *et al.* 2006). The damage on fruit is caused by larvae chewing on the surface of the fruit when they roll leaves against the fruit. The larvae are active and will fall onto the ground on a thread when disturbed. In addition, careful examination of the article by Hung *et al.* (2006) indicates that the insects were only found in April during lychee flowering and fruit development stage and not after May when the fruit are maturing. Thus it is unlikely to be on the export pathway. Note that *Statherotis leucaspis* was also assessed as not on the pathway in the IRA for longans and lychees from China and Thailand (DAFF 2004b).	Assessment not required	Assessment not required.	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Sympis rufibasis Guenee [Lepidoptera: Noctuidae]	Yes (Hung *et al.* 2006)	No record found	Yes (Nielsen *et al.* 1996) Not in WA (Poole 2010)	No Damage on leaves and shoots (Tan 1998; Hung *et al.* 2006)	Assessment not required	Assessment not required	No
Thalassodes falsaria Prout [Lepidoptera: Geometridae] Leaf-eating looper	Yes On lychee (Kuroko and Lewvanich 1993) In Taiwan (Inoue 2005)	No record found	No (Nielsen *et al.* 1996)	No On leaves and flowers (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Thalassodes immissarius Walker [Lepidoptera: Geometridae] Nettle caterpillar	Yes (Hung *et al.* 2006)	No (PPD 2012a)	No (Nielsen *et al.* 1996)	No *Thalassodes immissarius* was reported on lychees in Taiwan by Hung *et al.* (2006). Although it is listed as collected from flowers and fruit in Figure 4 by Hung *et al.* (2006), careful examination of the article indicates that the insects were only found in April during lychee flowering and fruit development stage and not after May when the fruit are maturing. Thus it is unlikely to be on the export pathway.	Assessment not required	Assessment not required	No
Unknown species A [Lepidoptera]	Yes (Hung *et al.* 2006)	Uncertain	Uncertain	No On lychee shoots (Hung *et al.* 2006)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Unknown species B [Lepidoptera]	Yes (Hung *et al.* 2006)	Uncertain	Uncertain	No Unknown species B was reported on lychees in Taiwan by Hung *et al.* (2006). Although it is listed as collected from flowers and fruit in Figure 4 by Hung *et al.* (2006), careful examination of the article indicates that the insects were only found in April during lychee flowering and fruit development stage and not after May when the fruit are maturing. Thus it is unlikely to be on the export pathway.	Assessment not required	Assessment not required	No
Zeuzera coffeae Neiter [Lepidoptera: Cossidae] Cossid moth	Yes (BAPHIQ 2004)	Yes (PPD 2010)	No (Nielsen *et al.* 1996)	No Damage on leaves and stems (Tan 1998; Wen and Liou 2008)	Assessment not required	Assessment not required	No
Order Orthoptera							
Chondracris rosea De Geer [Orthoptera: Acrididae] Citrus locust	Yes On lychee (Tan 1998) In Taiwan (Bigger 2009a)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	No (Rentz 2006)	No Damage on leaves (Tan 1998); leaf feeder (Bigger 2009a)	Assessment not required	Assessment not required	No
Locusta migratoria (L.) [Orthoptera: Acrididae] Oriental migratory locust	Yes On lychee (Tan 1998) In Taiwan (CABI 2012)	Yes On lychee (Tan 1998) In Vietnam (CABI 2012)	Yes (Rentz 2006)	Assessment not required	Assessment not required	Assessment not required	No
Tarbinskiellus portentosus (Lichtenstein) Synonym: *Brachytrupes portentosus* Lichtenstein [Orthoptera: Gryllidae] Large brown cricket	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	No (Rentz 2006)	No On seedlings (PPD 2010)	Assessment not required	Assessment not required	No
Order Thysanoptera							

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Chaetanaphothrips orchidii (Moulton) [Thysanoptera: Thripidae] Orchid thrips	Yes (CABI 2012)	No (CABI 2012)	Yes (Mound 2010) Not in WA (Poole 2010)	No *Chaetanaphothrips orchidii* prefers feeding within unopened leaves and flowers (CABI 2012).	Assessment not required	Assessment not required	No
Ernothrips lobatus (Bhatti) [Thysanoptera: Thripidae] Thrips	Yes (Masumoto and Okajima 2002)	No (Masumoto and Okajima 2002)	No (Mound 2010)	No On flowers and leaves (Masumoto and Okajima 2002)	Assessment not required	Assessment not required	No
Megalurothrips distalis (Karny) Synonym: *Taeniothrips nigricornis* [Thysanoptera: Thripidae] Thrips	Yes (CABI 2012)	No (CABI 2012)	Yes (CABI 2012) Not in WA (Poole 2010)	No On flowers (CABI 2012)	Assessment not required	Assessment not required	No
Scirtothrips dorsalis Hood [Thysanoptera: Thripidae] Chilli thrips	Yes (CABI-EPPO 2009)	No (CABI-EPPO 2009)	Yes (Mound 2010)	Assessment not required	Assessment not required	Assessment not required	No
Selenothrips rubrocinctus (Giard) [Thysanoptera: Thripidae] Red banded thrips	Yes (CABI 2012)	No (CABI 2012)	Yes (Mound 2010)	Assessment not required	Assessment not required	Assessment not required	No
Thrips coloratus Schmutz [Thysanoptera: Thripidae] Thrips	Yes On lychee (DOA 2003) In Taiwan (Chen 1979)	No record found	Yes (Mound 2010) Not in WA (Poole 2010)	No On flowers (DOA 2003)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Thrips hawaiiensis (Morgan) [Thysanoptera: Thripidae] Banana flower thrips	Yes On lychee (PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Mound 2010)	Assessment not required	Assessment not required	Assessment not required	No
Phylum Mullusca							
Class Gastropoda							
Order Stylommatophora							
Bradybaena similaris (Ferussac) [Stylommatophora: bradybaenidae] Asian tramp snail	Yes (Wen and Liou 2008)	Yes On lychee (Wen and Liou 2008) In Vietnam (CABI 2012)	Yes (Smith *et al.* 2002)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Kingdom Fungi							
Phylum Ascomycota							
Class Dothideomycetes							
Order Botryosphaeriales							
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. Synonym: *Botryodiplodia theobromae* Pat., *Diplodia theobromae* (Pat.) W Nowell Teleomorph: *Botryosphaeria rhodina* (Berk. & MA Curtis) Arx [Botryosphaeriales: Botryosphaeriaceae] Root rot, collar rot disease	Yes On lychee (Coates *et al.* 2005) In Taiwan (Matsushima 1980; CABI-EPPO 2010b)	Yes On lychee (Coates *et al.* 2005) In Vietnam (CABI-EPPO 2010b)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Order Capnodiales							
Graphiopsis chlorocephala Trail Synonym: *Cladosporium chlorocephaleum* (Fresen.) EW Mason & MB Ellis [Capnodiales: Davidiellaceae] Mitosporic fungi	Yes On lychee (Lyall and Mittal 1980; de Jager *et al.* 2004) In Taiwan (Shao *et al.* 2011; Anonymous 2011a)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2012)	No On leaves (Lyall and Mittal 1980)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Order Pleosporales							
Alternaria alternata (Fr.) Keissl. [Pleosporales: Pleosporaceae] Alteraria leaf spot	Yes On lychee (Coates *et al.* 1994; de Jager *et al.* 2004) In Taiwan (Matsushima 1980; Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Cochliobolus hawaiiensis Alcorn Anamorph: *Bipolaris hawaiiensis* (MB Ellis) JY Uchida & Aragaki; *Helminthosporium hawaiiense* Bugnic. [Pleosporales: Pleosporaceae]	Yes On lychee (Misra *et al.* 1972; Plant Health Australia 2001) In Taiwan (Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Corynespora cassiicola (Berk. & MA Curtis) CT Wei [Pleosporales: Corynesporascaceae] Leaf spot	Yes On lychee (Farr *et al.* 1989) In Taiwan (Matsushima 1980; Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No Associated with inflorescences (DOA 2003; DAFF 2004b) .	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Epicoccum nigrum Link Synonym: *Epicoccum purpurascens* Ehrenb.; *Phoma epicoccina* Punith., Tulloch & JG Leach [Pleosporales: Pleosporaceae]] Cereal leaf spot	Yes On lychee (Coates *et al.* 2005) In Taiwan (Tzean *et al.* 2010c; Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001; Johnson and Cooke 2002; DAFWA 2012)	Assessment not required	Assessment not required	Assessment not required	No
Munkovalsaria donacina (Niessl) Aptroot [Pleosporales: Dacampiaceae] Leaf spot	Yes On lychee (Thaung 2008) In Taiwan (Tzean *et al.* 2010a)	No record found	No (Plant Health Australia 2001)	No The species was collected on lychees in Burma as causing leaf spot and/or tar spot (Thaung 2008)	Assessment not required	Assessment not required	No
Sporidesmium filiferum Piroz. [Pleosporales: Incertae sedis]	Yes (Watanabe 1996)	No record found	No (Plant Health Australia 2001; DAFWA 2006)	No Collected from dead leaves and twigs of lychees in Taiwan (Watanabe 1996)	Assessment not required	Assessment not required	No
Sporidesmium tropicale MB Ellis [Pleosporales: Incertae sedis]	Yes (Matsushima 1980)	No record found	No (Plant Health Australia 2001)	No Infects twigs (Matsushima 1980)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Order Not yet placed							
Dimeriella dendrocalami Sawada & W Yamam. [Incertae sedis: Parodiopsidaceae]	Yes (BAPHIQ 2004)	No record found	No (Plant Health Australia 2001)	No Infects leaves (Tai 1979; BAPHIQ 2004)	Assessment not required	Assessment not required	No
Class Eurotiomycetes							
Order Chaetothyriales							
Chaetothyrium javanicum (Zimm.) Boedijn Synonym: *Limacinula javanica* (Zimm.) Höhn., *Phaeosaccardinula javanica* (Zimm.) Sacc. & D Sacc. [Chaetothyriales: Chaetothyriaceae] Sooty mould	Yes (BAPHIQ 2004)	No record found	No (Plant Health Australia 2001)	No Infects leaves (BAPHIQ 2004)	Assessment not required	Assessment not required	No
Order Eurotiales							
Aspergillus brasiliensis Varga, Frisvad & Samson Synonym: *Aspergillus niger* Tiegh. [Eurotiales: Trichocomaceae] Collar rot, black rot	Yes On lychee (CABI 2012) In Taiwan (Tzean *et al.* 2010c; Shao *et al.* 2011)	Yes On lychee (CABI 2012) In Vietnam (Burgess and Burgess 2009)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Aspergillus flavus Link [Eurotiales: Trichocomaceae] Aspergillus rot	Yes On lychee (Zhuang 2001; Kaiser and Saha 2005) In Taiwan (Tzean *et al.* 2010c; Shao *et al.* 2011)	Yes On lychee (Zhuang 2001; Kaiser and Saha 2005) In Vietnam (Burgess and Burgess 2009)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Aspergillus glaucus Link [Eurotiales: Trichocomaceae] Aspergillus rot	Yes On lychee (Scott *et al.* 1982; Zhuang 2001) In Taiwan (Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	Yes Detected in rotted fruit (Scott *et al.* 1982)	Yes The cosmopolitan distribution of *A. glaucus* worldwide (Farr and Rossman 2011) including eastern Australia indicates that the pest can establish and spread in Western Australia.	No *Aspergillus glaucus* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners. This is supported by the fact that this species is not listed as a prohibited disease in the WA *Plant Diseases Regulations 1989* (WAL 2011).	No
Aspergillus restrictus G Sm. [Eurotiales: Trichocomaceae] Aspergillus rot	Yes On lychee (Huang and Scott 1985; Farr *et al.* 1989) In Taiwan (Tzean *et al.* 2010c; Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	Yes Causes rot of fruit (DAWA 2003)	Yes The cosmopolitan distribution of *A. restrictus* worldwide (Farr and Rossman 2011) including eastern Australia indicates that the pest can establish and spread in Western Australia.	No As assessed previously, *A. restrictus* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners (DAFF 2004b). This is supported by the fact that this species is not listed as a prohibited disease in the WA *Plant Diseases Regulations 1989* (WAL 2011).	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Penicillium aurantiogriseum Dierckx [Eurotiales: Trichocomaceae]	Yes On lychee (Lichter *et al.* 2004) In Taiwan (Tzean *et al.* 2010d)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	Yes Infects fruit (Lichter *et al.* 2004)	Yes The cosmopolitan distribution of *Penicillium aurantiogriseum* worldwide (Farr and Rossman 2011) including eastern Australia indicates that the pest can establish and spread in Western Australia.	No *P. aurantiogriseum* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners. This is supported by the fact that this species is not listed as a prohibited disease in the WA *Plant Diseases Regulations 1989* (WAL 2011).	No
Penicillium brevicompactum Dierckx [Eurotiales: Trichocomaceae] Green mould	Yes (Tzean *et al.* 2010d)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	Yes Collected from rhizosphere of lychee in Taiwan (Tzean *et al.* 2010d). It can infect postharvest fruit (Coates *et al.* 2005).	Yes The fact that the pathogen can infect postharvest fruit (Coates *et al.* 2005) indicates that it is able to establish and spread in Western Australia.	No *Penicillium brevicompactum* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners. This is supported by the fact that this species is not listed as a prohibited disease in the WA *Plant Diseases Regulations 1989* (WAL 2011).	No
Penicillium chrysogenum Thom [Eurotiales: Trichocomaceae] Green mould	Yes On lychee (Coates *et al.* 2005) In Taiwan (Tzean *et al.* 2010d)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	Yes Infects fruit (Coates *et al.* 2005)	Yes The cosmopolitan distribution of *P. chrysogenum* worldwide (Farr and Rossman 2011) including eastern Australia indicates that the pest can establish and spread in Western Australia.	No *Penicillium chrysogenum* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners. This is supported by the fact that this species is not listed as a prohibited disease in the WA *Plant Diseases Regulations 1989* (WAL 2011).	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Penicillium expansum Link [Eurotiales: Trichocomaceae]	Yes On lychee (de Jager *et al.* 2004) In Taiwan (Tzean *et al.* 2010d)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Penicillium solitum var. *crustosum* (Thom) Bridge, D Hawksw., Kozak., Onions, RRM Paterson & Sackin Synonym: *Penicillium crustosum* Thom [Eurotiales: Trichocomaceae]	Yes On lychee (Plant Health Australia 2001) In Taiwan (Tzean *et al.* 2010d)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	Yes Infects fruit (Plant Health Australia 2001)	Yes The cosmopolitan distribution of *P. solitum* var. *crustosum* worldwide (Farr and Rossman 2011) including eastern Australia indicates that the pest can establish and spread in Western Australia.	No *Penicillium solitum* var. *crustosum* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners. This is supported by the fact that this species is not listed as a prohibited disease in the WA *Plant Diseases Regulations 1989* (WAL 2011).	No
Class Hyphomycetes							
Order Not yet placed							
Solicorynespora litchi (Matsush.) RF Castañeda & WB Kendr. [Incertae sedis: Incertae sedis]	Yes (Matsushima 1980)	No record found	No (Plant Health Australia 2001)	No Infects leaves (Matsushima 1980)	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Class Saccharomycetes							
Order Saccharomycetales							
Endomyces magnusii F. Ludw. Synonym: *Magnusiomyces magnusii* (F Ludw.) Redhead & Malloch Anamorph: *Geotrichum ludwigii* (EC Hansen) SF Fang, TC Yen & JC Yen [Saccharomycetales: Endomycetaceae] Sour rot	Yes (BAPHIQ 2004) As *Magnusiomyces magnusii* (F Ludw.) Redhead & Malloch	No record found	No (Plant Health Australia 2001)	Yes Anamorph (*Geotrichum ludwigii*) of *Endomyces magnusii* can cause postharvest disease (Coates *et al.* 2005).	Yes Species of *Geotrichum* have a worldwide distribution and are found in soil, water, air, and sewage, as well as in plants, cereals, and dairy products. *Geotrichum ludwigii* is known to cause postharvest disease of fruit such as lychees (Coates *et al.* 2005) and it is likely to establish and spread in Australia if introduced.	No *Endomyces magnusii* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners.	No
Geotrichum candidum Link [Saccharomycetales: Dipodascaceae] Sour rot	Yes (Tsai and Hsieh 1998)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Class Sordariomycetes							
Order Hypocreales							
Acremonium zonatum (Sawada) W Gams [Hypocreales: Incertae sedis] Zonate leaf spot	Yes On lychee (Hawksworth 1976) In Taiwan (Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No Infects leaves (Hawksworth 1976)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Albonectria rigidiuscula (Berk. & Broome) Rossman & Samuels Anamorph: *Fusarium decemcellulare* Brick 1908 [Hypocreales: Nectriaceae] Cushion gall disease	Yes On lychee(Coates *et al.* 2005) In Taiwan (Tzean *et al.* 2010a; Shao *et al.* 2011)	Yes On lychee (Coates *et al.* 2005) In Vietnam (Burgess and Burgess 2009)	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No Infects branches (Coates *et al.* 2005) and stems (Plant Health Australia 2001)	Assessment not required	Assessment not required	No
Calonectria morganii Crous, Alfenas & MJ Wingf. Anamorph: *Cylindrocladium scoparium* Morg. [Hypocreales: Nectriaceae] White mould	Yes On lychee (Coates *et al.* 2005) In Taiwan (Matsushima 1980; Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001) Note that the ananorph *Cylindrocladium scoparium* is listed as present in WA (DAFWA 2006), although DAFWA (2012) indicates that there is no record of *Calonectria morganii* in WA, probably due to overlooking of the anamorphic synonym.	Assessment not required	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Cylindrocarpon lichenicola (C Massal.) D Hawksw. Synonym: *Cylindrocarpon tonkinense* Bugnic. [Hypocreales: Nectriaceae]	Yes On lychee (Coates *et al.* 2003) In Taiwan (Matsushima 1980; Brayford 1987)	Yes On lychee (Prasad and Bilgrami 1972; Coates *et al.* 2003) In Vietnam (Brayford 1987)	Yes (Prasad and Bilgrami 1972; Brayford 1987) Not in WA (DAFWA 2006)	Yes Causes postharvest disease of fruit (Prasad and Bilgrami 1972; Coates *et al.* 2003)	Yes The hosts of this pathogen include a wide range of woody and herbaceous plants (Mycobank 2012). This pathogen is present in eastern Australia and is likely to establish and spread in WA if introduced	No *Cylindrocarpon lichenicola* is not considered of economic significance in commercially produced fruit during production and for either domestic or international trade by Australia and its trading partners (DAFF 2004b). This is supported by the fact that this species is not listed as a prohibited disease in the WA *Plant Diseases Regulations 1989* (WAL 2011).	No
Fusarium incarnatum (Desm.) Sacc. Synonym: *Fusarium semitectum* Berk. & Ravenel, *Fusarium pallidoroseum* (Cooke) Sacc. [Hypocreales: Nectriaceae]	Yes On lychee (Awasthi *et al.* 2005; Kaiser and Saha 2005) In Taiwan (Tzean *et al.* 2010a)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium moniliforme var. *moniliforme* J Sheld. [Hypocreales: Nectriaceae]	Yes On lychee (Zhuang 2001) In Taiwan (Tzean *et al.* 2010a)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Haematonectria haematococca (Berk & Broome) Samuels & Rossman Anamorph: *Fusarium solani* (Mart.) Sacc. [Hypocreales: Nectriaceae]	Yes On lychee (PPD 2010) In Taiwan (Tzean *et al.* 2010a)	Yes (PPD 2010)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Memnoniella echinata (Rivolta) Galloway [Hypocreales: Incertae sedis]	Yes On lychee (Kirk 1991) In Taiwan (Matsushima 1980)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No *Memnoniella echinata* is a cosmopolitan fungus but is most commonly found in tropical and subtropical areas; usually in soils and plant debris but also inside buildings, especially on cellulose-based materials (Mycobank 2012).	Assessment not required	Assessment not required	No
Trichoderma aureoviride Rifai [Hypocreales: Hypocreaceae]	Yes On lychee (Mirza *et al.* 2004) In Taiwan (Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No There is limited available information on the biology of this pathogen. However, *Trichoderma* species are free-living fungi that are common in soil and root ecosystems; they are also opportunistic, avirulent plant symbionts, as well as being parasites of other fungi (Harman *et al.* 2004). There are no reports of this pathogen on lychee fruit.	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Order Xylariales							
Pestalotia litchi Sawada [Xylariales: Amphisphaeriaceae] Leaf blight	Yes (BAPHIQ 2004)	No record found	No (Plant Health Australia 2001)	No Infects leaves (BAPHIQ 2004)	Assessment not required	Assessment not required	No
Order Not yet placed							
Colletotrichum acutatum JH Simmonds Teleomorph: *Glomerella acutata* Guerber & JC Correll [Incertae sedis: Glomerellaceae] Anthracnose	Yes On lychee (Coates *et al.* 1994) In Taiwan (CABI-EPPO 2010a)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Glomerella cingulata (Stoneman) Spauld. & H Schrenk Anamorph: *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. [Incertae sedis: Glomerellaceae] Leaf necrosis, anthracnose, pepper spot	Yes (BAPHIQ 2004)	Yes (PPD 2010)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Class Not yet placed							
Order Not yet placed							
Camposporium japonicum Ichinoe [Incertae sedis: Incertae sedis] Sooty mould	Yes (Matsushima 1980)	No record found	No (Plant Health Australia 2001)	No Infects leaves (Matsushima 1980)	Assessment not required	Assessment not required	No
Phylum Basidiomycota							
Class Agaricomycetes							
Order Agaricales							
Armillaria mellea (Vahl) P Kumm. [Agaricales: Physalacriaceae] Armillaria root rot	Yes On lychee (Coates *et al.* 2005) In Taiwan (Shao *et al.* 2011)	Yes On lychee (Coates *et al.* 2005) In Vietnam (UK CAB International 1980)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Order Cantharellales							
Thanatephorus cucumeris (AB Frank) Donk Anamorph: *Rhizoctonia solani* JG Kühn [Cantharellales: Ceratobasidiaceae]	Yes On lychee (Coates *et al.* 2005) In Taiwan (Shao *et al.* 2011)	Yes (PPD 2010)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Order Hymenochaetales							
Phellinus noxius (Corner) G Cunn. [Hymenochaetales: Hymenochaetaceae] Brown root rot	Yes (BAPHIQ 2004)	Yes (PPD 2010)	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No Infects roots and stem (Ann *et al.* 1999)	Assessment not required	Assessment not required	No
Order Polyporales							
Ganoderma lucidium (Curtis) P Karst [Polyporales: Ganodermataceae]	Yes On lychee (Kobayashi 2007) In Taiwan (Tzean *et al.* 2010b)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Phanerochaete salmonicolor (Berk. & Broome) Jülich Synonym: *Corticium salmonicolor* Berk. & Broome, *Erythricium salmonicolor* (Berk. & Broome) Burds. [Polyporales: Phanerochaetaceae] Pink disease, pink limb blight	Yes On lychee (Mossler 2009; PPD 2010) In Taiwan (CABI 2012)	Yes (PPD 2010)	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No Infects branches and trunk (Mossler 2009)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Class Pucciniomycetes							
Order Pucciniales							
Skierka nephelii S Ito & Muray. Synonym: *Uredo nephelii* (S Ito & Muray.) Hirats. f. [Pucciniales: Pileolariaceae] Leaf rust	Yes (BAPHIQ 2004)	No record found	No (Plant Health Australia 2001)	No Infects leaves (DOA 2003; BAPHIQ 2004)	Assessment not required	Assessment not required	No
Phylum Zygomycota							
Class Mucormycotina							
Order Mucorales							
Rhizopus arrhizus A Fisch. Synonym: *Rhizopus oryzae* Went & Prins. Geerl. [Mucorales: Incertae sedis] Rhizopus rot	Yes On lychee (Coates *et al.* 2005) In Taiwan (Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001; DAFWA 2012)	Assessment not required	Assessment not required	Assessment not required	No
Rhizopus stolonifer (Ehrenb.) Vuill. [Mucorales: Incertae sedis] Rhizopus rot	Yes On lychee (Coates *et al.* 2005) In Taiwan (Shao *et al.* 2011)	No record found	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Kingdom Chromista							
Class Oomycota							
Order Peronosporales							
Phytophthora cinnamomi Rands [Peronosporales: Peronosporaceae] Phytophthora dieback	Yes On lychee (PPD 2010) In Taiwan (UK CAB International 1991)	Yes (PPD 2010)	Yes (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora litchii (CC Chen ex WH Ko, HS Chang, HJ Su, CC Chen & LS Leu) Voglmayr, Göker, Riethm. & Oberw. As *Peronophythora litchii* CC Chen ex WH Ko, HS Chang, HJ Su, CC Chen & LS Leu in PPD (2010) Invalidly published name: *Peronophythora litchii* CC Chen (Chen 1961; Ko *et al.* 1978) [Peronosporales: Peronosporaceae] Downy blight, blossom blight, brown blight	Yes (BAPHIQ 2004)	Yes (PPD 2010) Note PPD (2012a) stated that *Phytophthora litchii* is absent in Vietnam but it is recognised that *Peronophythora litchii,* listed by PPD (2010), is a synonym of *Phytophthora litchii.*	No (Plant Health Australia 2001)	Yes Infects immature and ripe fruit, leaves and flowers (Coates *et al.* 2005)	Yes *Phytophthora litchii* is found on lychee in China, Taiwan and Japan (Farr and Rossman 2011). Taiwan has a humid subtropical climate similar to south east Queensland and northern New South Wales according to the Koppen climate classification system. Thus the species could establish in Australian lychee production areas.	Yes *Phytophthora litchii* causes damages to lychee and is a important pest in lychee production areas of Taiwan and Vietnam (BAPHIQ 2012a; PPD 2012b).	Yes ^{EP}

Pest	On lychee and/or in Taiwan	On lychee and/or in Vietnam	Present within Australia	Potential to be on the pathway	Potential for establishment and spread	Potential for economic consequences	Consider further?
Phytophthora sp. [Peronosporales: Peronosporaceae]	Uncertain	Yes (PPD 2010)	Uncertain	Yes On leaves and fruit (PPD 2010)	Yes Lychees are planted in Queensland and northern New South Wales where climatic conditions would be suitable for the pathogen’s establishment and spread.	Yes *Phytophthora* species can cause considerable damage to a wide range of crops. For example, *Phytophthora litchi* is an important pest of lychee (BAPHIQ 2012a; PPD 2012b) and *P. cinnamoni* causes rot and dieback on host plants (CABI 2012).	Yes VN
Kingdom Plantae							
Phylum Chlorophyta							
Class Ulvophyceae							
Order Trentepohiales							
Cephaleuros virescens Kunze ex EM Fries [Trentepohliales: Trentepohliaceae] Algal leaf spot, green scurf	Yes On lychee (Coates *et al.* 2005) In Taiwan (Shao *et al.* 2011)	Yes (PPD 2010)	Yes (Plant Health Australia 2001) Not in WA (DAFWA 2006)	No Infects leaves and branches (Coates *et al.* 2005)	Assessment not required	Assessment not required	No

Pest	**On lychee and/or in Taiwan**	**On lychee and/or in Vietnam**	**Present within Australia**	**Potential to be on the pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Consider further?**
Unknown Aetiology							
Witches' broom	No (BAPHIQ 2012a)	No (PPD 2012a)	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No

Appendix B Additional quarantine pest data

Quarantine pest	***Bactrocera cucurbitae* Coquillet ^{EP}**
Synonyms	*Dacus cucurbitae* Coquillett, 1899 *Chaetodacus cucurbitae* (Coquillett) *Dacus aureus* Tseng and Chu *Dacus yuiliensis* Tseng & Chu *Strumeta cucurbitae* (Coquillett) *Zeugodacus cucurbitae* (Coquillett)
Common name(s)	Melon fruit fly
Main hosts	Recorded from more than 125 host plant species including lychee (Wen 1985; CABI 2012) Plants in the family Cucurbitaceae are the usual hosts. For a comprehensive list, see CABI (2012).
Distribution	Presence in Australia: No. Although detected in Christmas Island and an ocassional out break in the Torres Straight Protection Zone (CSIRO 2005) there are quarantine measures in place to prevent its spread into mainland Australia. Presence in Taiwan: Yes (Wen 1985). Presence in Vietnam: Yes (CABI 2012). Presence elsewhere: Widely distributed in Asia, but also occurs in Africa, North America and Oceania regions (CABI 2012).
Quarantine pest	***Bactrocera dorsalis* (Hendel) ^{EP}**
Synonyms	*Dacus dorsalis* Hendel, 1912 *Bactrocera conformis* Doleschall, 1858 (preocc.) *Bactrocera ferrugineus* (Fabricius) *Chaetodacus dorsalis* (Hendel) *Chaetodacus ferrugineus* (Fabricius) *Chaetodacus ferrugineus dorsalis* (Hendel) *Chaetodacus ferrugineus okinawanus* Shiraki, 1933 *Dacus ferrugineus* Fabricius *Dacus ferrugineus dorsalis* Fabricius *Dacus ferrugineus* var. *dorsalis* Fabricius *Dacus ferrugineus okinawanus* (Shiraki) *Musca ferruginea* Fabricius (preocc.) *Musca ferruginea* Fabricius, 1794 *Strumeta dorsalis* (Hendel) *Chaetodacus ferrugineus* (Fabricius) *Strumeta ferrugineus* (Fabricius)
Common name(s)	Oriental fruit fly
Main hosts	Recorded from more than 150 host fruits and vegetables species. For a comprehensive list, see CABI (2012).
Distribution	Presence in Australia: No record found. Presence in Taiwan: Yes (Drew and Hancock 1994; Wen and Liou 2008). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: Widely distributed in Asia (CABI 2012).
Quarantine pest	***Ischnaspis longirostris* (Signoret, 1882) $^{EP, WA}$**
Synonyms	*Mytilaspis longirostris* Signoret, 1882 *Ischnaspis longirostris* (Hempel, 1900) *Ischnaspis filiformis* Douglas, 1887 *Mytilaspis ritzemaebosi* Leonardi, 1901 *Lepidosaphes ritsemabosi* (Fernald, 1903)
Common name(s)	Black thread scale, black line scale
Main hosts	Recorded from 70 genera across 35 families including: *Citrus*, *Cocos nucifera* (coconut), *Coffea* (coffee), *Mangifera indica* (mango), *Persea americana* (avocado) and *Musa* spp. (banana). For a comprehensive list, see Ben-Dov *et al.* (2012).

Distribution	Presence in Australia: Yes. Present in NT and Qld (Ben-Dov *et al.* 2012), but no record found for presence in WA (Poole 2010). Presence in Taiwan: Yes (Ben-Dov *et al.* 2012). Presence in Vietnam: Yes (Ben-Dov *et al.* 2012). Presence elsewhere: Near-cosmopolitan throughout North and South America, Africa, Europe and Asia (Ben-Dov *et al.* 2012).
Quarantine pest	***Parlatoria cinerea* Danne & Hadden** ^{EP}
Synonyms	None
Common name(s)	Tropical grey chaff scale
Main hosts	Recorded on many host plants include: *Annona muricata* (soursop); *Citrus* spp.; *Citrus aurantifolia* (lime); *Citrus latifolia* (Tahitian limes); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus reticulata* (mandarin); *Citrus sinensis* (sweet orange); *Malus sylvestris* (crabapple); *Vitis vinifera* (wine grape) (Ben-Dov *et al.* 2012).
Distribution	Presence in Australia: No (Ben-Dov *et al.* 2012). Presence in Taiwan: Yes (Ben-Dov *et al.* 2012). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: Cook Islands; French Polynesia; New Caledonia; Niue; Pitcairn; Samoa; Vanuatu (Ben-Dov *et al.* 2012).
Quarantine pest	***Selenaspidus articulatus* (Morgan)** $^{EP, WA}$
Synonyms	*Aspidiotus articulatus* *Selenaspidus articulatus simplex*
Common name(s)	Rufous scale; West Indian red scale.
Main hosts	Recorded from 122 wild and commercial host species belonging to 48 plant families (Ben-Dov *et al.* 2012). This species is an important pest of commercial plants, particularly citrus, coffee and olives. For a comprehensive list, see Ben-Dov *et al.* (2012).
Distribution	Presence in Australia: Yes (Ben-Dov *et al.* 2012), but no record found for presence in WA (Poole 2010). Presence in Taiwan: Yes (Ben-Dov *et al.* 2012). Presence in Vietnam: No record found. Presence elsewhere: widely distributed throughout the world and is found in temperate and tropical countries on every continent (Ben-Dov *et al.* 2012).
Quarantine pest	***Dysmicoccus lepelleyi* (Betrem, 1937)**
Synonyms	*Pseudococcus lepelleyi* Betrem, 1937 *Criniticoccus palmae* Lit, 1992
Common name(s)	None available, referred as mealybug in this report
Main hosts	Recorded from more than 30 genera across 17 families including: *Garcinia mangostana* (mangosteen); *Mangifera indica* (mango); *Ficus variegata* (variegated fig); *Psidium guajava* (guava); *Coffea* (coffee); *Citrus; Litchi chinensis* (lychee); *Nephelium lappaceum* (rambutan); *Theobroma cacao* (cacao); and *Musa* (banana). For a comprehensive list, see Ben-Dov (2011).
Distribution	Presence in Australia: No (Ben-Dov 2011). Presence in Taiwan: Yes (Williams 2004). Presence in Vietnam: Yes. Although PPD (2012a) noted that this species is absent from Vietnam, it has actually been intercepted on many host plants from Vietnam to Russia and USA (Williams 2004). Presence elsewhere: Southeast Asia (Williams 2004).
Quarantine pest	***Paracoccus interceptus* Lit, 1997**
Synonyms	*Allococcus morrisoni* Ezzat & McConnell, 1956 *Planococcus morrisoni* (Cox & Ben-Dov, 1986) *Paracoccus morrisoni* Lit, 1997
Common name(s)	Intercepted mealybug

Main hosts	Recorded from more than 24 host plant species across 18 families including: *Garcinia mangostana* (mangosteens); *Mangifera indica* (mango); *Annona cherimola* (custard apple); *Ficus* (fig); *Psidium guajava* (guava); *Citrus*; *Litchi chinensis* (lychee); and *Nephelium lappaceum* (rambutan). For a comprehensive list, see (Williams 2004).
Distribution	Presence in Australia: No records found Presence in Taiwan: Yes (Ben-Dov 2011). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: Southeast Asia (Williams 2004).
Quarantine pest	***Planococcus lilacinus* (Cockerell, 1905) EP**
Synonyms	*Pseudococcus tayabanus* Cockerell, 1905 *Dactylopius crotonis* Green, 1906 *Dactylopius coffeae* Newstead, 1908 *Pseudococcus coffeae* (Sanders, 1909) *Dactylopius crotonis* Green, 1911 *Pseudococcus crotonis* (Sasscer, 1912) *Pseudococcus deceptor* Betrem, 1937 *Tylococcus mauritiensis* Mamet, 1939 *Planococcus crotonis* (Ferris, 1950) *Planococcus tayabanus* (Ferris, 1950)
Common name(s)	Coffee mealybug
Main hosts	Recorded from a wide host range across 35 families including: *Theobroma cacao* (cocoa); *Psidium guajava* (guava); *Coffea* spp. (coffee); and *Mangifera indica* (mango). For a comprehensive list, see Ben-Dov (2011).
Distribution	Presence in Australia: No (Ben-Dov 2011). Although recently detected in Torres Strait Islands, there are quarantine measures in place to prevent its spread into mainland Australia Presence in Taiwan: Yes (Ben-Dov 2011). Presence in Vietnam: Yes (Ben-Dov 2011). Presence elsewhere: Near-cosmopolitan including Central America, East Africa, South, South-east and East Asia (CABI 2012).
Quarantine pest	***Planococcus litchi* Cox EP**
Synonyms	None
Common name(s)	Litchi mealybug
Main hosts	Recorded on many host plants include: *Eriobotrya japonica* (loquat); *Litchi chinensis* (lychee) (Ben-Dov 2011).
Distribution	Presence in Australia: No (Ben-Dov 2011). Presence in Taiwan: No (Ben-Dov 2011). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: China (Hong Kong), Japan, Philippines, Thailand (Ben-Dov 2011).
Quarantine pest	***Planococcus minor* (Maskell, 1897) EP, WA**
Synonyms	*Dactylopius calceolariae minor* Maskell, 1897 *Pseudococcus calceolariae minor* (Fernald, 1903) *Planococcus pacificus* Cox, 1981 *Planococcus psidii* Cox, 1989
Common name(s)	Pacific mealybug, passionvine mealybug
Main hosts	Recorded from a wide host range across 70 families including: *Garcinia mangostana* (mangosteen); *Citrus deliciosa* (mediterranean mandarin); *Citrus reticulata* (mandarin); *Acacia* sp.; *Coffea* (coffee); *Colocasia esculenta* (taro); *Mangifera indica* (mango); *Psidium guajava* (guava); *Eucalyptus deglupta* (rainbow eucalyptus); and *Zea mays* (maize). For a comprehensive list, see William (2004) and CABI (2012).

Distribution	Presence in Australia: Yes. Present in ACT, NT, Qld and SA (Ben-Dov 2011), but no record found for presence in WA (Poole 2010). Presence in Taiwan: Yes (Ben-Dov 2011). Presence in Vietnam: Yes (Williams 2004; USDA 2011). Presence elsewhere: Central and South America, East Africa, Oceania, South and Southeast Asia (Williams 2004; CABI 2012).
Quarantine pest	***Pseudococcus cryptus* Hempel,1918 EP**
Synonyms	*Pseudococcus citriculus* Green, 1922 *Pseudococcus spathoglottidis* Lit, 1992 *Pseudococcus mandarinus* Das & Ghose, 1996
Common name(s)	Cryptic mealybug, citriculus mealybug, ground orchid mealybug
Main hosts	Recorded from a wide host range across 45 families including: *Citrus*; *Garcinia mangostana* (mangosteen); *Litchi chinensis* (lychee); *Coffea Arabica* (coffee); *Ananas sativa* (pineapple); *Musa* (banana); and *Vitis vinifera* (grape vine). For a comprehensive list, see Ben-Dov (2011).
Distribution	Presence in Australia: No (Ben-Dov 2011). Although detected at the tip of Cape York Peninsula, there are quarantine measures in place to prevent its spread Presence in Taiwan: Yes (Ben-Dov 2011). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: South and Central America, East Africa, Mid-eastern Mediterranean, South, South-east and East Asia, Oceania except Australia and New Zealand (Williams 2004).
Quarantine pest	***Pseudococcus jackbeardsleyi* Gimpel & Miller EP**
Synonyms	None
Common name(s)	Jack Beardsley mealybug
Main hosts	Recorded from a wide host range across 44 families. For a comprehensive list, see Ben-Dov (2011).
Distribution	Presence in Australia: No (Ben-Dov 2011). Although recently detected at Torres Strait Islands, there are quarantine measures in place to prevent its spread. Presence in Taiwan: Yes (Ben-Dov 2011). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: Africa, Asia, Pacific islands, north, central and south Americas (Ben-Dov 2011).
Quarantine pest	***Conopomorpha sinensis* Bradley EP**
Synonyms	None
Common name(s)	Litchi fruit borer
Main hosts	Recorded on many host plants including *Dimocarpus longan* (longan) and *Litchi chinensis* (lychee) (He, 2001; Hwang and Hung, 1996; Waite and Hwang, 2002).
Distribution	Presence in Australia: No (Nielsen *et al.* 1996). Presence in Taiwan: Yes (BAPHIQ 2004). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: China, India, Taiwan and Thailand (Hwang and Hung 1996; Waite and Hwang 2002).

Quarantine pest	***Adoxophyes orana* (Fischer von Röeslerstamm, 1834) EP**
Synonyms	*Adoxophyes fasciata* Walsh *Adoxophyes reticulana* Hübner *Adoxophyes tripsiana* *Cacoecia reticulana* *Capua congruana* *Capua orana* *Capua reticulana* Hübner *Tortrix orana* Fischer von Röeslerstamm *Tortrix reticulana*.
Common name(s)	Summer fruit tortrix moth
Main hosts	*Adoxophyes orana* is highly polyphagous and larvae have been recorded feeding on the leaves and fruits of plants in many different families. For a comprehensive list, see CABI (2012).
Distribution	Presence in Australia: No (Nielsen *et al.* 1996). Presence in Taiwan: Yes (Huang *et al.* 1997) Presence in Vietnam: No (CABI 2012). Presence elsewhere: Armenia, Austria, Azerbaijan, Belgium, Bulgaria, China (Hebei, Hong Kong, Sichuan), Denmark, Finland, France, Georgia (Republic), Germany, Hungary, Italy, Japan (Hokkaido, Honshu, Kyushu, Shikoku), Netherlands, Norway, Poland, Romania, Russian Federation (Russian Far East, Siberia), Korea, Republic of, Spain, Sweden, Switzerland, Ukraine, United Kingdom (England, Wales), Yugoslavia (CABI 2012).
Quarantine pest	***Phytophthora litchii* (CC Chen ex WH Ko, HS Chang, HJ Su, CC Chen & LS Leu) Voglmayr, Göker, Riethm. & Oberw EP**
Synonyms	*Peronophythora litchii* Chen ex Ko. Chang, Su, Chen & Leu. *Peronophythora litchii* Chen 1961 (invalid name)
Common name(s)	Downy blight
Main hosts	*Litchi chinensis* (lychee) (BAPHIQ 2004; Coates *et al.* 2005). Some fruits of tomato, pawpaw and loofah have been artificially inoculated (CABI 2012).
Distribution	Presence in Australia: No record found. Presence in Taiwan: Yes (BAPHIQ 2004). Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: China; Japan; Papua New Guinea and Thailand (Chi *et al.* 1984; DOA 2003; CABI 2012).
Quarantine pest	***Phytophthora* sp.**
Synonyms	None
Common name(s)	
Main hosts	*Litchi chinensis* (lychee) (PPD 2010).
Distribution	Presence in Australia: Uncertain. Presence in Taiwan: Uncertain. Presence in Vietnam: Yes (PPD 2010). Presence elsewhere: Uncertain.

Appendix C Biosecurity framework

Australia's biosecurity policies

The objective of Australia's biosecurity policies and risk management measures is the prevention or control of the entry, establishment or spread of pests and diseases that could cause significant harm to people, animals, plants and other aspects of the environment.

Australia has diverse native flora and fauna and a large agricultural sector, and is relatively free from the more significant pests and diseases present in other countries. Therefore, successive Australian Governments have maintained a conservative, but not a zero-risk, approach to the management of biosecurity risks. This approach is consistent with the World Trade Organization's (WTO's) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).

The SPS Agreement defines the concept of an 'appropriate level of protection' (ALOP) as the level of protection deemed appropriate by a WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. Among a number of obligations, a WTO Member should take into account the objective of minimising negative trade effects in setting its ALOP.

Like many other countries, Australia expresses its ALOP in qualitative terms. Australia's ALOP, which reflects community expectations through Australian Government policy, is currently expressed as providing a high level of sanitary and phytosanitary protection, aimed at reducing risk to a very low level, but not to zero.

Consistent with the SPS Agreement, in conducting risk analyses Australia takes into account as relevant economic factors:

- the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease in the territory of Australia
- the costs of control or eradication of a pest or disease
- and the relative cost-effectiveness of alternative approaches to limiting risks.

Roles and responsibilities within Australia's quarantine system

Australia protects its human[9], animal and plant life or health through a comprehensive quarantine system that covers the quarantine continuum, from pre-border to border and post-border activities.

Pre-border, Australia participates in international standard-setting bodies, undertakes risk analyses, develops offshore quarantine arrangements where appropriate, and engages with our neighbours to counter the spread of exotic pests and diseases.

At the border, Australia screens vessels (including aircraft), people and goods entering the country to detect potential threats to Australian human, animal and plant health.

---

[9] The Australian Government Department of Health and Ageing is responsible for human health aspects of quarantine.

The Australian Government also undertakes targeted measures at the immediate post-border level within Australia. This includes national co-ordination of emergency responses to pest and disease incursions. The movement of goods of quarantine concern within Australia's border is the responsibility of relevant state and territory authorities, which undertake inter- and intra-state quarantine operations that reflect regional differences in pest and disease status, as a part of their wider plant and animal health responsibilities.

Roles and responsibilities within the Department

The Australian Government Department of Agriculture, Fisheries and Forestry is responsible for the Australian Government's animal and plant biosecurity policy development and the establishment of risk management measures. The Secretary of the Department is appointed as the Director of Animal and Plant Quarantine under the *Quarantine Act 1908* (the Act).

The Department takes the lead in biosecurity and quarantine policy development and the establishment and implementation of risk management measures across the biosecurity continuum, and:

- **Pre-border** conducts risk analyses, including IRAs, and develops recommendations for biosecurity policy as well as providing quarantine policy advice to the Director of Animal and Plant Quarantine
- **At the border** develops operational procedures, makes a range of quarantine decisions under the Act (including import permit decisions under delegation from the Director of Animal and Plant Quarantine) and delivers quarantine services
- **Post-border** coordinates pest and disease preparedness, emergency responses and liaison on inter- and intra-state quarantine arrangements for the Australian Government, in conjunction with Australia's state and territory governments.

Roles and responsibilities of other government agencies

State and territory governments play a vital role in the quarantine continuum. The Department works in partnership with state and territory governments to address regional differences in pest and disease status and risk within Australia, and develops appropriate sanitary and phytosanitary measures to account for those differences. Australia's partnership approach to quarantine is supported by a formal Memorandum of Understanding that provides for consultation between the Australian Government and the state and territory governments.

Depending on the nature of the good being imported or proposed for importation, DAFF may consult other Australian Government authorities or agencies in developing its recommendations and providing advice.

As well as a Director of Animal and Plant Quarantine, the Act provides for a Director of Human Quarantine. The Australian Government Department of Health and Ageing is responsible for human health aspects of quarantine and Australia's Chief Medical Officer within that Department holds the position of Director of Human Quarantine. DAFF may, where appropriate, consult with that Department on relevant matters that may have implications for human health.

The Act also requires the Director of Animal and Plant Quarantine, before making certain decisions, to request advice from the Environment Minister and to take the advice into account when making those decisions. The Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) is responsible under the *Environment Protection and Biodiversity Conservation Act 1999* for assessing the environmental impact associated with proposals to import live species. Anyone proposing to import such material should contact DSEWPaC directly for further information.

When undertaking risk analyses, DAFF consults with DSEWPaC about environmental issues and may use or refer to DSEWPaC's assessment.

Australian quarantine legislation

The Australian quarantine system is supported by Commonwealth, state and territory quarantine laws. Under the Australian Constitution, the Commonwealth Government does not have exclusive power to make laws in relation to quarantine, and as a result, Commonwealth and state quarantine laws can co-exist.

Commonwealth quarantine laws are contained in the *Quarantine Act 1908* and subordinate legislation including the Quarantine Regulations 2000, the Quarantine Proclamation 1998, the Quarantine (Cocos Islands) Proclamation 2004 and the Quarantine (Christmas Island) Proclamation 2004.

The quarantine proclamations identify goods, which cannot be imported, into Australia, the Cocos Islands and or Christmas Island unless the Director of Animal and Plant Quarantine or delegate grants an import permit or unless they comply with other conditions specified in the proclamations. Section 70 of the Quarantine Proclamation 1998, section 34 of the Quarantine (Cocos Islands) Proclamation 2004 and section 34 of the Quarantine (Christmas Island) Proclamation 2004 specify the things a Director of Animal and Plant Quarantine must take into account when deciding whether to grant a permit.

In particular, a Director of Animal and Plant Quarantine (or delegate):

- must consider the level of quarantine risk if the permit were granted, and
- must consider whether, if the permit were granted, the imposition of conditions would be necessary to limit the level of quarantine risk to one that is acceptably low, and
- for a permit to import a seed of a plant that was produced by genetic manipulation – must take into account any risk assessment prepared, and any decision made, in relation to the seed under the *Gene Technology Act*, and
- may take into account anything else that he or she knows is relevant.

The level of quarantine risk is defined in section 5D of the *Quarantine Act 1908*. The definition is as follows:

> reference in this Act to a *level of quarantine risk* is a reference to:
>
> (a) the probability of:
>
> (i) a disease or pest being introduced, established or spread in Australia, the Cocos Islands or Christmas Island; and

(ii) the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and

(b) the probable extent of the harm.

The Quarantine Regulations 2000 were amended in 2007 to regulate keys steps of the import risk analysis process. The Regulations:

- define both a standard and an expanded IRA;
- identify certain steps, which must be included in each type of IRA;
- specify time limits for certain steps and overall timeframes for the completion of IRAs (up to 24 months for a standard IRA and up to 30 months for an expanded IRA);
- specify publication requirements;
- make provision for termination of an IRA; and
- allow for a partially completed risk analysis to be completed as an IRA under the Regulations.

The Regulations are available at http://www.comlaw.gov.au

International agreements and standards

The process set out in the *Import Risk Analysis Handbook 2011* is consistent with Australia's international obligations under the SPS Agreement. It also takes into account relevant international standards on risk assessment developed under the International Plant Protection Convention (IPPC) and by the World Organisation for Animal Health (OIE).

Australia bases its national risk management measures on international standards where they exist and when they achieve Australia's ALOP. Otherwise, Australia exercises its right under the SPS Agreement to apply science-based sanitary and phytosanitary measures that are not more trade restrictive than required to achieve Australia's ALOP.

Notification obligations

Under the transparency provisions of the SPS Agreement, WTO Members are required, among other things, to notify other members of proposed sanitary or phytosanitary regulations, or changes to existing regulations, that are not substantially the same as the content of an international standard and that may have a significant effect on trade of other WTO Members.

Risk analysis

Within Australia's quarantine framework, the Australian Government uses risk analyses to assist it in considering the level of quarantine risk that may be associated with the importation or proposed importation of animals, plants or other goods.

In conducting a risk analysis, DAFF:

- identifies the pests and diseases of quarantine concern that may be carried by the good

- assesses the likelihood that an identified pest or disease or pest would enter, establish or spread
- assesses the probable extent of the harm that would result.

If the assessed level of quarantine risk exceeds Australia's ALOP, DAFF will consider whether there are any risk management measures that will reduce quarantine risk to achieve the ALOP. If there are no risk management measures that reduce the risk to that level, trade will not be allowed.

Risk analyses may be carried out by DAFF's specialists, but may also involve relevant experts from state and territory agencies, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities and industry to access the technical expertise needed for a particular analysis.

Risk analyses are conducted across a spectrum of scientific complexity and available scientific information. An IRA is a type of risk analysis with key steps regulated under the Quarantine Regulations 2000. DAFF's assessment of risk may also take the form of a non-regulated analysis of existing policy or technical advice. Further information on the types of risk analysis is provided in the *Import Risk Analysis Handbook 2011*.

Glossary

Term or abbreviation	Definition
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 2012).
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).
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2012).
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 2012).
Arthropod	The largest phylum of animals, including the insects, arachnids and crustaceans.
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 2012).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2012).
Diapause	Period of suspended development/growth occurring in some insects, in which metabolism is decreased
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 2012).
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 2012).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2012).
Fecundity	The fertility of an organism.
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2012).
Fumigation	Treatment with a chemical agent that reaches the commodity wholly or primarily in a gaseous state (FAO 2012).
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.
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2012).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2012).
Import risk analysis	An administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication.
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2012).
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 2012).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2012).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2012).
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 2012).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2012).
Larva	A juvenile form of animal with indirect development, undergoing metamorphosis (for example, insects or amphibians).

Term or abbreviation	Definition
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin etc., forming part of a consignment (FAO 2012). Within this report a 'lot' refers to a quantity of fruit of a single variety, harvested from a single production site during a single pick and packed at one time.
Mortality	The total number of organisms killed by a particular disease.
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2012).
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 2012).
Orchard	A contiguous area of lychee trees operated as a single entity. Within this report a single orchard is covered under one registration and is issued a unique indentifying number.
Parthenognesis	Production of an embryo from unfertilised egg.
Pathogen	Micro-organism causing disease (FAO 2012).
Pathway	Any means that allows the entry or spread of a pest (FAO 2012).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2012).
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 2012).
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 2012).
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 2012).
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 managed as a separate unit in the same way as a pest free place of production (FAO 2012).
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 2012).
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 2012).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2012).
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 2012).
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 2012).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2012).
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 2012).
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2012).
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 2012).
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 2012).

Term or abbreviation	Definition
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 2012).
Production site	In this report, a production site is a continuous planting of lychee trees treated as a single unit for pest management purposes. If an orchard is subdivided into one or more units for pest management purposes, then each unit is a production site. If the orchard is not subdivided, then the orchard is also the production site.
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 2012).
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 2012).
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 2012).
Regulated pest	A quarantine pest or a regulated non-quarantine pest (FAO 2012).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2012).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
Stakeholders	Government agencies, individuals, community or industry groups or organisations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues
Surveillance	An official process which collects and records data on pest occurrence or absence by surveying, monitoring or other procedures (FAO 2012).
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 (FAO 2012).
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 2012).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.
Viable	Alive, able to germinate or capable of growth.

References

AFFA (2002) *Import risk analysis for the importation of fresh pineapple fruit: final IRA report. Plus five apendices.* Agriculture, Fisheries and Forestry - Australia (AFFA), Canberra.

ALGA (2012) Australian Lychee Growers Association (ALGA). http://www.australianlychee.com.au/# Accessed 3 April 2012.

Ann PJ, Lee HL, Huang TC (1999) Brown root rot of 10 species of fruit trees caused by *Phellinus noxius* in Taiwan. *Plant Disease* 83: 746–750.

Anonymous (2011a) A checklist of the Taiwan fungi. http://web2.nmns.edu.tw/TFungi/english/ Accessed September 2011a.

Anonymous (2011b) *Dudusa synopla* Swinhoe. www.jpmoth.org/~dmoth/Digital_Moths_of_Asia/75_Notodontidae/01_Dudusinae/01_Dudusa/Dudusa%20synopha/Dudusa%20synopia.htm Accessed August 2011b.

AQIS (1998a) *Final import risk analysis of the importation of fruit of Fuji apple (Malus pumila Miller var. domestica Schneider) from Aomori prefecture in Japan*. Australian Quarantine and Inspection Service, Canberra.

AQIS (1998b) *Final import risk analysis of the importation of fruit of Ya pear (Pyrus bretschneideri Redh.) from the People's Republic of China (Hebei and Shandong Provinces)*. Australian Quarantine and Inspection Service, Canberra.

AQIS (1999a) *Final import risk analysis on the importation of fresh durian fruit (Durio zibethinnus Murray) from the Kingdom of Thailand*. Australian Quarantine and Inspection Service, Canberra.

AQIS (1999b) *Final import risk analysis on the proposal to change the treatment for mango (Mangifera indica L.) fruit from the Republic of the Philippines*. Australian Quarantine and Inspection Service, Canberra.

AQIS (2010) Interception pest data since commercial trade started for lychees from China and Thailand in 2004.

AQSIQ (2003a) *Response to Biosecurity Australia Questions [on longan and lychees from China]*. General Administration of Quality Supersision, Inspection and Quarantine of the People's Republic of China (AQSIQ), Beijing.

AQSIQ (2003b) *Response to Biosecurity Australia questions, March 2003*. General Administration for Quality Supervision, Inspection and Quarantine of the People's Republic of China, Beijing.

Awasthi DP, Sarkar S, Mishra NK, Kaiser SAKM (2005) Disease situation of some major fruit crops in new alluvial plains of West Bengal. *Environment and Ecology* Suppl. 3: 497–499.

Bakr RFA, Badawy RM, Mousa SF, Hamooda LS, Atteia SA (2009) Ecological and taxonomic studies on the scale insects that infest mango trees at Qaliobiya governorate. *Egyptian Academy Journal of Biological Sciences* 2: 69–89.

BAPHIQ (2004) *Production and cultivation of litchi, carambola and mango in Taiwan*. Bureau of Animal and Plant Inspection and Quarantine, Council of Agriculture, Executive Yuan, Taiwan.

BAPHIQ (2012a) *Additional information requested for pest risk analysis for lychees from Taiwan*. Bureau of Animal and Plant Health Inspection and Quarantine (BAPHIQ), Council of Agriculture, Executive Yuan, Taipei.

BAPHIQ (2012b) *Supplementary information of verification visit for fresh lychees from Taiwan July 2, 2012*. Bureau of Animal and Plant Health Inspection and Quarantine (BAPHIQ), Taipei.

BBC Weather (2012) Weather Hanoi. http://www.bbc.co.uk/weather/1581130 Accessed July 2012.

Beardsley JW Jr, Gonzalez RH (1975) The biology and ecology of armored scales. *Annual Review of Entomology* 20: 47–73.

Ben-Dov Y (2011) Pseudococcidae. ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/scalenet/scalenet.htm Accessed 29 November 2011.

Ben-Dov Y (2012a) Coccidae. ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/scalenet/scalenet.htm Accessed 2012a.

Ben-Dov Y (2012b) Kerriidae. ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/scalenet/valid.htm Accessed September 2012b.

Ben-Dov Y, Hodgson CJ (1997) *Soft scale insects: their biology, natural enemies and control Vol. 7B.* Ben-Dov Y, Hodgson CJ (eds) Elsevier Science Publishers B.V., Amsterdam.

Ben-Dov Y, Miller DR, Denno BD, Gimpel ME (2012) Diaspididae. ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/scalenet/scalenet.htm Accessed September 2012.

Bigger M (2009a) A geographical distribution list of insects and mites associated with cocoa, derived from literature published before 2010. Integrated Pest Management Reviews. www.ipmnetwork.net/commodity/cocoa_insects.pdf Accessed 12 May 2010a.

Bigger M (2009b) A geographical distribution list of insects and mites associated with coffee, derived from literature published before 2010. Integrated Pest Management Reviews. http://www.ipmnetwork.net Accessed 21 April 2011b.

Biosecurity Australia (2003) *Import of Asian ('Shandong') pear (Pyrus pyrifolia (Burm.) Nakai and P. ussuriensis var. viridis T. Lee) fruit from Shandong Province in the People's Republic of China: a review under existing import conditions for Ya pear (Pyrus bretschneideri Redh.) fruit from Hebei and Shandong Provinces*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2005) *Final extension of policy for the importation of pears from the People's Republic of China*. Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2006a) *Final report: import risk analysis for Tahitian limes from New Caledonia*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2006b) *Policy for the importation of fresh mangoes (Mangifera indica L.) from Taiwan*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2008a) *Final import risk analysis report for fresh mango fruit from India*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2008b) *Final import risk analysis report for the importation of Cavendish bananas from the Philippines. Part A, B and C*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2010) *Final import risk analysis report for fresh apple fruit from the People's Republic of China*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2011) *Final import risk analysis report for table grapes from the People's Republic of China*. Department of Agriculture, Fisheries and Forestry, Canberra.

Borowiec L, Swietojanska J (2011) Cassidinae of the world - an interactive manual (Coleoptera: Chrysomelidae). www.biol.uni.wroc.pl/cassidae/katalog%20internetowy/index.htm Accessed August 2011.

Bradley JD (1986) Identity of the South-East Asian cocoa moth, *Conopomorpha cramarella* (Snellen) (Lepidoptera: Bracillariidae), with descriptions of three allied new species. *Bulletin of Entomological Research* 76: 41–45.

Brayford D (1987) *Cylindrocarpon lichenicola*. *CMI descriptions of pathogenic fungi and bacteria* 93: 926–926.

Burgess LW, Burgess JS (2009) Capacity building in plant pathology: soilborne diseases in Vietnam, 1993-2009. *Australasian Plant Pathology* 38: 325–333.

CABI (2012) Crop Protection Compendium. CAB International, Wallingford, UK. http://www.cabi.org/cpc Accessed 2012.

CABI-EPPO (1997) Datasheets on quarantine pests: *Aleurocanthus woglumi*. European and Mediterranean Plant Protection Organization. http://www.eppo.org/ Accessed 27 March 2009.

CABI-EPPO (2009) Datasheets on quarantine pests: *Scirtothrips dorsalis*. European and Mediterranean Plant Protection Organization. http://www.eppo.org/QUARANTINE/insects/Scirtothrips_dorsalis/SCITDO_ds.pdf Accessed 15 December 2011.

CABI-EPPO (2010a) *Colletotrichum acutatum*. Distribution maps of plant diseases No.705. http://www.cabi.org/dmpd/FullTextPDF/2010/20103281414.pdf Accessed September 2011a.

CABI-EPPO (2010b) *Lasiodiplodia theobromae*. Distribution Maps of Plant Diseases No.561. http://www.cabi.org/dmpd/FullTextPDF/2010/20103281413.pdf Accessed September 2011b.

Carter DJ (1984) *Pest Lepidoptera of Europe: with special reference to the British Isles.* Dr W. Junk Publishers, Dordrecht.

Carver M, Gross GF, Woodward TE (1991) Hemiptera (bugs, leafhoppers, cicadas, aphids, scale insects etc.). In Naumann ID, Carne PB, Lawrence JF, Nielsen ES, Spradbery JP, Taylor RW, Whitten MJ, Littlejohn MJ (eds) *The insects of Australia: a textbook for students and research workers* 429–509. Melbourne University Press, Carlton.

Cassis G, Gross G (2002) Infraorder Pentatomomorpha. Australian Biological Resources Study: Australian Faunal Directory. http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/PENTATOMOMORPHA Accessed 9 September 2011.

Cassis G, Houston WWK, Weir TA, Moore BP, Calder AA (2002) Coleoptera: Scarabaeoidea. Australian Biological Resources Study: Australian Faunal Directory. http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/ Accessed 20 September 2011.

Chao JT (2011) Noctudid moths of Taiwan. Taiwan Forestry Research Institute. www.discoverlife.org/mp/20q?guide=Taiwan_Noctuidae Accessed August 2011.

Chao JT, Shafer PW, Fan YB, Lu SS (1996) Host plants and infestation of casuarina moth *Lymantria xylina* in Taiwan. *Journal of Forest Science* 11: 23–28.

Chen CC (1961) A species of *Peronophythora*, gen. nov, parasitic on lichi fruit in Taiwan. *Special publication of the College of Agriculture, National Taiwan University* 10: 1–37.

Chen LS (1979) Thrips infesting tea in Taiwan. *Plant Protection Bulletin (Taichung)* 21: 377–382.

Chen WH, Hwang JS, Wu ZC (2008) Study of the Family Fulgoridae (Hemiptera, Fulgoroidea) in Taiwan. 2008 Workshop: Research and Status of Taiwan Species Diversity. http://2008checklist.biodiv.tw/disc2008/doc/267_poster.pdf Accessed October 2011.

Chi P, Pang S, Liu R (1984) On downy blight of *Litchi chinensis sonn.:* the pathogen and its infection process. *Acta Phytopathologica Sinica* 14: 113–119.

CIE (1974) *Homona coffearia*. pp. 330–330. *Distribution Maps of Pests* Series A, Commonwealth Institute of Entomology, London.

CISEH (2012) Passionvine mealybug *Planococcus minor* (Maskell). http://www.invasive.org/browse/subinfo.cfm?sub=11769 Accessed 23 February 2012.

Coates L, Zhou E, Sittigul C (2005) Diseases. In Menzel CM, Waite GK (eds) *Litchi and longan: botany, production and uses* 261–272. CAB International, Wallingford.

Coates LM, Johnson GI, Sardsud U, Cooke AW (1994) Postharvest disease of lychee in Australia, and their control. *ACAIR Proceedings* 58: 68–69.

Coates LM, Sangchote S, Johnson GI, Sittigul C (2003) Diseases of longan, lychee and rambutan. In Ploetz RC (ed) *Diseases of tropical fruit crops* 307–325. CAB International, Wallingford.

Cox JM (1987) Pseudococcidae (Insecta: Hemiptera). *Fauna of New Zealand* 11: 1–229.

CSIRO (2005) Australian insect common names version 1.53. http://www.ces.csiro.au/aicn/name_s/b_1.htm Accessed 29 November 2011.

CUT (2012) Carambola fruit borer *Eucosma notanthes* Meyrick. http://pheromone.cyut.edu.tw/insect_cont.php?Key=14&uID=1&cID=28 Accessed 7 May 2012.

DAFF (2004a) *Final import risk analysis report: Mangosteen fruit from Thailand*. Department of Agriculture, Fisheries and Forestry, Canberra.

DAFF (2004b) *Longan and lychee fruit from the People's Republic of China and Thailand: Final import risk analysis report - Part A and Part B*. Department of Agriculture, Fisheries and Forestry, Canberra.

DAFF (2004c) *Mangosteen fruit from Thailand: final import risk analysis report*. Department of Agriculture, Fisheries and Forestry, Canberra.

DAFF (2004d) *Persimmon fruit (Diospyros kaki L.) from Japan, Korea and Israel: final import policy*. Department of Agriculture, Fisheries and Forestry, Canberra.

DAFF (2012) *Final report for the non-regulated analysis of existing policy for fresh mangosteen fruit from Indonesia*. Department of Agriculture, Fisheries and Forestry, Canberra.

DAFWA (2006) *Draft plant pathology lists of pathogen species*. Department of Agriculture, Government of Western Australia, Western Australia.

DAFWA (2012) *Comments on draft pest categorisation for fresh lychee fruit from Taiwan and Vietnam*. Government of Western Australia, Department of Agriculture and Food, South Perth.

Davis EE, French S, Venette RC (2005) *Mini risk assessment: summer fruit tortrix moth, Adoxophyes orana (Fischer von Roslerstamm, 1834) [Lepidoptera: Tortricidae]*. University of Minnesota, St. Paul, Minnesota.

DAWA (2003) *Stakeholder comments on technical issues paper for import risk analysis of fresh longan and lychee fruit from the People's Republic of China*. Department of Agriculture, Fisheries and Forestry, Canberra.

de Jager ES, Wehner FC, Korsten L (2004) Fungal postharvest pathogens of litchi fruit in South Africa. *Yearbook South African Litchi Growers' Association* 15: 24–32.

de Prins J, de Prins W (2011) Global taxonomic database of Gracillariidae (Lepidoptera). www.gracillariidae.net Accessed August 2011.

DEEDI (2011) *Cocoa pod borer - Emergency plant pest response plan*. Queensland Government Department of Employment, Economic Development and Innovation, Brisbane.

Dekle GW (1965) Florida armored scale insects. *Arthropods of Florida and neighboring land areas* 3: 1–265.

Dekle GW (1976) Florida armored scale insects. *Arthropods of Florida and neighboring land areas* 3: 1–345.

DFAT (2012) Travel advice for Taiwan. Department of Foreign Affairs and Trade, Australian Government. http://www.smartraveller.gov.au/zw-cgi/view/Advice/Taiwan Accessed 18 July 2012.

Dhillon MK, Singh R, Naresh JS, Sharma HC (2005) The melon fruit fly, *Bactrocera cucurbitae*: a review of its biology and management. *Journal of Insect Science* 5: 1–16.

DITARI (2011) Digital insect of Taiwan Agricultural Research Institute. http://digiins.tari.gov.tw/tarie/treelist001E.php?id=Hemiptera&lev1=3&lev2=0/20/27/&lev3=04&page=1 Accessed September 2011.

DOA (2003) *Application for market access of litchi from Thailand to Australia*. Department of Agriculture, Ministry of Agriculture and Cooperatives, Bangkok.

DPI Victoria (2012) *DPI Victoria comments on the draft pest categorisation table for the analysis of existing policy for import of fresh lychee fruit from Taiwan and Vietnam*. Department of Primary Industries, Victoria, Melbourne.

Drew RAI, Hancock DL (1994) The *Bactrocera dorsalis* complex of fruit flies (Diptera: Tephritidae: Dacinae) in Asia. *Bulletin of Entomological Research* Suppl. 2: 1–68.

Esaki T (1926) List of the Heteroptera of Formosa. *Ann.Hist.-Nat.Mus.Natl.Hung.* 24: 136–189.

FAO (1999) *International Standards for Phytosanitary Measures (ISPM) no. 10: Requirements for the establishment of pest free places of production and pest free production sites*. Food and Agriculture Organization of the United Nations, Rome.

FAO (2003) *International Standards for Phytosanitary Measures (ISPM) no. 18: Guidelines for the use of irradiation as a phytosanitary measure*. Food and Agriculture Organization of the United Nations, Rome.

FAO (2004) *International Standards for Phytosanitary Measures (ISPM) no. 11: Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms*. Food and Agriculture Organization of the United Nations, Rome.

FAO (2007) *International Standards for Phytosanitary Measures (ISPM) no. 2: Framework for pest risk analysis*. Food and Agriculture Organization of the United Nations, Rome.

FAO (2012) *International Standards for Phytosanitary Measures (ISPM) no. 5: Glossary of phytosanitary terms*. Food and Agriculture Organisation of the United Nations, Rome.

Farr DF, Bills GF, Chamuris GP, Rossman AY (1989) *Fungi on plants and plant products in the United States*. The American Phytopathological Society Press, St. Paul, Minnesota.

Farr DF, Rossman AY (2011) Fungal databases. United States Department of Agriculture, Agricultural Research Service, National Genetic Resources Program, Germplasm Resources Information Network. http://nt.ars-grin.gov/fungaldatabases/ Accessed October 2011.

Fay H (2005) Fruity piercing moth on citrus: a perspective including control developments. Department of Primary Industries and Fisheries, Queensland. http://www2.dpi.qld.gov.au/horticulture/5541.html Accessed 9 December 2010.

Fletcher MJ, Watson S (2009) Hemiptera: Auchenorryhncha. Australian Faunal Directory, Australian Biological Resources Study, Canberra. http://environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/Auchenorrhyncha Accessed September 2011.

Funkhouser WD (1943) Synonymy of the Membracidae of Formosa. *Journal of New York Entomological Society* 51: 265–275.

Furness GO, Charles JG (1994) Mealybugs. In Nicholas P, Margery P, Wachtel M (eds) *Diseases and pests* 54–55. Winetitles, Adelaide.

Ghose SK (1961) Studies on some coccids (Coccoidea: Hemiptera) of economic importance of West Bengal, India. *Indian Agriculturist* 5: 57–78.

Giliomee JH (1990) The adult male. In Rosen D (ed) *Armored scale insects: their biology, natural enemies and control. Vol. 4A* 21–28. Elsevier Science Publishers B.V., Amsterdam.

Halliday RB (2000) Arachinda: Acarina. Australian Biological Resources Study: Australian Faunal Directory. http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/ACARINA Accessed 3 June 2008.

Harman GE, Howell CR, Viterbo A, Chet I, Matteo M (2004) *Trichoderma* species - opportunistic, avirulent plant symbionts. *Nature Reviews Mycology* 2: 43–56.

Hawksworth DL (1976) *Acremonium zonatum*. *CMI descriptions of pathogenic fungi and bacteria No.502* 51.

He DP (2001) An overview of integrated management of insect pests in litchi orchards of Guangdong. In Huang H, Menzel C (eds) *Proceedings of the first interational symposium on litchi and longan: Acta Horticulturae 558* 401–405. International Society for Horticultural Science, Belgium.

Hely PC, Pasfield G, Gellatley JG (1982) *Insect pests of fruit and vegetables in NSW*. Department of Agriculture, Sydney.

Heppner JB, Bae YS (2010) Notes on Taiwan moths 6. *Cerace stipatana* (Lepidoptera: Tortricidae: Tortricinae). *Lepidoptera Novae* 3: 195–198.

Herbison-Evans D, Crossley S (2005) *Conopomorpha cramerella* (Snellen, 1904). http://lepidoptera.butterflyhouse.com.au/grac/cramer.html Accessed September 2011.

Hill DS (1983) *Agricultural insect pests of the tropics and their control*. Cambridge University Press, London.

Hollis D, Eastop VF (2005) Hemiptera: Aphidoidea. Australian Faunal Directory, Australian Biological Resources Study, Canberra. http://environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/aphidoidea Accessed September 2011.

Hong XY, Zhang ZQ (1996) *The eriophyoid mites of China: an illustrated catalogue and identification keys (Acari: Prostigmata: Eriophyoidea)*. Associated Publishers, Gainesville.

Horak M (2006) *Olethreutine moths of Australia (Lepidoptera: Tortricidae)*. Commonwealth Scientific and Industrial Research Organisation, Collingwood.

Huang CQ, Wu HQ, Lin YW, Xie YD, Huang J, Huang BK (1997) A review of shoot and fruit borers and two species of gracillariid moths attacking litchi and longan. *Wuyi Science Journal* 13: 125–130.

Huang PY, Scott KJ (1985) Control of rotting and browning of litchi fruit after harvest at ambient temperatures in China. *Tropical Agriculture (Trinidad)* 62: 2–4.

Huang T, Huang KW, Horng IJ (1990) Two species of eriophyid mites injurious to litchi trees in Taiwan. *Chinese Journal of Entomology* Special Publication 3: 57–64.

Hung CC, Hwang JS, Wang HY (2006) Survey of lepidopterous pests of litchi and longan in Taiwan. *Formosan Entomologist* 28: 315–320.

Hung SH, Ho KY, Chen CC (2009) Preliminary report on the occurrence of litchi gall midge, *Litchiomyia chinensis* (Diptera: Cecidomyiidae) in the Chiayi area, Taiwan. *Formosan Entomologist* 28: 315–320.

Hwang JS, Hung CC (1996) Gracillariid insect pests attacking litchi and longan in Taiwan. *Plant Protection Bulletin Taipei* 38: 75–78.

Inayoshi Y (2011a) *Rapala pheretima petosiris* (Hewitson 1863). A Check List of Butterflies in Indo-China.Chiefly from Thailand, Laos & Vietnam. http://yutaka.it-n.jp/lyc4/83840010.html Accessed September 2011a.

Inayoshi Y (2011b) *Rapala varuna orseis* Hewitson (1863). A Check List of Butterflies in Indo-China.Chiefly from Thailand, Laos & Vietnam. http://yutaka.it-n.jp/lyc4/83930010.html Accessed September 2011b.

Inoue H (1964) Some new subspecies of the Geometridae from the Ryukyu Archipeligo and Formosa (Lepidoptera). *Kontyû, Tokyo* 32: 335–340.

Inoue H (2005) Notes on Thalassodes-group of moths (Geometridae, Geometrinae) from Taiwan, with description of a new species. *Transactions of the Lepidopterological Society of Japan* 56: 279–286.

Jeppson LR, Keifer HH, Baker EW (1975) *Mites injurious to economic plants.* University of California, Berkeley.

Johnson GI, Cooke AW (2002) Postharvest disease control in lychee. *Acta Horticulturae (ISHS)* 575: 705–715.

Kaiser SAKM, Saha B (2005) Diseases of major fruit crops in the red and lateritic zones of West Bengal. *Journal of Mycopathological Research* 43: 233–237.

Kimoto S (1966) A list of the chrysomelid specimens of Taiwan preserved in the Zoological Museum, Berlin. *Esakia* 5: 21–38.

Kimoto S (1989) Chrysomelidae (Coleoptera) of Thailand, Cambodia, Laos and Vietnam IV. Galerucinae. *Esakia* 27: 1–241.

Kirk PM (1991) Memnoniella echinata. pp. 1055–1055. *IMI Descriptions of Fungi and Bacteria* 106, CAB International.

Kluesener A (1994) Unusual catocaline from Taiwan. *Tropical Lepidoptera News* 3-4: 4–4.

Ko WH, Chang HS, Su HJ, Chen CC, Leu LS (1978) Peronophythoraceae, a new family of Peronosporales. *Mycologia* 70: 380–384.

Kobayashi T (2007) *Index of fungi inhabiting woody plants in Japan: host, distribution and literature.* Zenkoku-Noson-Kyoiku Kyokai Publishing Company Ltd, Tokyo.

Kosztarab M (1990) Economic importance. In Rosen D (ed) *Armored scale insects: their biology, natural enemies and control. Vol. 4B* 307–311. Elsevier Science Publishers B.V., Amsterdam.

Koteja J (1990a) Embryonic development: ovipary and vivipary. In Rosen D (ed) *Armored scale insects: their biology, natural enemies and control. Vol. 4A* 233–242. Elsevier Science Publishers B.V., Amsterdam.

Koteja J (1990b) Life history. In Rosen D (ed) *Armoured scale insects: their biology, natural enemies and control. Vol. 4A* 243–254. Elsevier Science Publishers B.V., Amsterdam.

Kuroko H, Lewvanich A (1993) *Lepidopterous pests of tropical fruit trees in Thailand.* Japan International Cooperation Agency, Tokyo.

Li CS (1993) Review of the Australian Epilachninae (Coleoptera: Coccinellidae). *Journal of the Australian Entomological Society* 32: 209–224.

Li LY, Wang R, Waterhouse DF (1997) *The distribution and importance of arthropod pest and weeds of agriculture and forestry plantations in Southern China.* The Chinese Academy of Agricultural Sciences, Beijing, China and the Australian Centre for International Agricultural Research, Canberra.

Lichter A, Dvir O, Ackerman M, Feygenberg O, Pesis E (2004) Acidified peel of litchi fruits selects for postharvest *Penicillium* decay. *Phytoparasitica* 32: 226–236.

Lyall P, Mittal RK (1980) *Litch chinensis:* a new host for *Cladosporium chlorocephalum*. *Environment India* 3: 87–87.

Ma CS (2006) Pests, diseases and weeds of apples. Key Laboratory of Agriculture Department, China. http://www.ecolsafety.org.cn//db/Fruit/login_pg.asp Accessed 1 September 2006.

Maki M (1916) *Report on injurious insects of the mulberry tree in Formosa.* Formosan Government Agricultural Experiment Station, Formosa (Taiwan).

Masumoto M, Okajima S (2002) A revision of the genus *Ernothrips* Bahtti (Thysanoptera: Thripidae), with description of a new species from Thailand. *Entomological Science* 5: 19–28.

Matsushima T (1980) *Saprophytic microfungi from Taiwan: part 1, hyphomycetes.* Matsushima Fungus Collection, Kobe.

McClure MS (1990a) Impact on host plants. In Rosen D (ed) *Armored scale insects: their biology, natural enemies and control. Vol. 4A* 289–291. Elsevier Science Publishers B.V., Amsterdam.

McClure MS (1990b) Seasonal history. In Rosen D (ed) *Armored scale insects: their biology, natural enemies and control. Vol. 4A* 315–318. Elsevier Science Publishers B.V., Amsterdam.

Meijerman L, Ulenberg SA (2011) *Archips machlopis* (Meyrick 1912). Arthropods of Economic Importance. http://wbd.etibioinformatics.nl/bis/tortricidae.php?menuentry=soorten&id=127 Accessed August 2011.

Menzel C (2002) *The lychee crop in Asia and the Pacific*. RAP Publication: 2002/16, Regional Office for Asia and the Pacific, Food and Agriculture Organisation of the United Nations, Bangkok.

Migeon A, Dorkeld F (2012) Spider mites web: a comprehensive database for the Tetranychidae. http://www1.montpellier.inra.fr/CBGP/spmweb/ Accessed May 2012.

Miller DR, Davidson JA (1990) A list of the armored scale insect pests. In Rosen D (ed) *Armored scale insects: their biology, natural enemies and control. Vol. 4B* 299–306. Elsevier Science Publishers B.V., Amsterdam.

Miller GL, Miller DR (2002) *Dysmicoccus* Ferris and similar genera (Hemiptera: Coccoidea: Pseudococcidae) of the gulf state region including a description of a new United States records. *Proceedings of the Entomological Society of Washington* 104: 968–979.

Milonas PG, Savopoulou-Soultani M (2004) Diapause termination in overwintering larvae of a Greek strain of *Adoxophyes orana* (Lepidoptera: Tortricidae). *Environmental Entomology* 33: 513–519.

Mirza JH, Akhtar N, Bajwa R (2004) Additions to fungi imperfecti of Pakistan. *Mycopathologia* 2: 65–66.

Misra AP, Prakash O, Misra B (1972) Fruit rot of litchi (*Litchi chinensis*) caused by *Helminthosporium hawaiiense* Bugincourt. *Indian Journal of Horticulture* 29: 355–356.

Mossler M (2009) Florida crop/pest management profile: lychee and longan. http://edis.ifas.ufl.edu/pdffiles/PI/PI05000.pdf Accessed September 2011.

Mound LA (2010) Thysanoptera. Australian Faunal Directory, Australian Biological Resources Study, Canberra. http://environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/thysanoptera Accessed September 2011.

Mycobank (2012) Fungal database: Nomenclature and species banks: Online taxonomic novelties submission. Administered by the International Mycological Association. http://www.mycobank.org/mycotaxo.aspx Accessed 24 February 2012.

NAQS (2012) Northern Australia Quarantine Strategy (NAQS). http://www.daff.gov.au/aqis/quarantine/naqs Accessed 17 April 2012.

Nielsen ES, Edwards ED, Rangsi TV (1996) *Checklist of the Lepidoptera of Australia.* Commonwealth Scientific and Industrial Research Organisation, Collingwood.

Norgaard RB (1988) The biological control of cassava mealybug in Africa. *American Journal of Agricultural Economics* 70: 366–371.

Ooi PAC, Winotai A, Peña JE (2002) Pests of minor tropical fruits. In Peña JE, Sharp JL, Wysoki M (eds) *Tropical fruit pests and pollinators: biology, economic importance, natural enemies and control* 315–321. CAB International, Wallingford.

Oriental Travel (2012) Taiwan map. http://www.orientaltravel.com/Taiwan_map.htm Accessed 22 August 2012.

Osborne LS, Durant LO, Jackson M, Fooshee C (2005) Mealybugs: introduction to mealybugs. Insect and related pests of flowers and foliage plants: some important, common, and potential pests in the southeastern United States. http://www.mrec.ifas.ufl.edu/lso/entomol/ncstate/mealy.htm Accessed 6 May 2008.

Pfeiffer DG, Schultz PB (1986) *Major insect and mite pests of grape in Virginia*. VPI and SU Virginia Cooperative Extensive Service, Virginia.

PIRSA (2012) *Comments on draft pest categorisation table*. Government of South Australia, Primary Industries and Regions SA, Adelaide.

Plant Health Australia (2001) Australian plant pest database, online database. www.planthealthaustralia.com.au/appd Accessed 1 June 2012.

Poole MC (2010) *An annotated catalogue of insect and allied species associated with Western Australian agriculture and related industries: perennial draft, July 2010*. Department of Agriculture and Food, Government of Western Australia.

PPD (2010) *A proposal to export lychee fruit (Litchi chinensis Sonn) from Vietnam to Australia*. Plant Protection Department, Ministry of Agriculture and Rural Development, Vietnam.

PPD (2012a) *Additional information for PRA of lychees from Vietnam (PPD, Vietnam_Feb_2012). Attachment 1 to letter dated 14 February 2012. Plant Protection Department (PPD)*. Ministry of Agriculture and Rural Development, Hanoi, Vietnam.

PPD (2012b) *Report on pests on lychees*. Plant Protection Department (PPD), Ministry of Agriculture and Rural Development, Hanoi, Vietnam.

PPD (2012c) *[Enlish translation of chemicals used in lychee orchards and pest management in VietGap for lychees]*. Plant Protection Department (PPD), Ministry of Agriculture and Rural Development, Hanoi, Vietnam.

Prasad SS, Bilgrami RS (1972) Unrecorded *Cylindrocarpon rot* of litchi from Muzaffarpur, India. *Indian Phytopathology* 25: 459–461.

Razowski J (2000) Tortricidae (Lepidoptera) collected in Taiwan, with description of one new genus and eight new species, and a comparison with some regional faunas. *Zoological Studies* 39: 319–327.

RDEC (2010) *The handy guide for foreigners in Taiwan*. Research, Development and Evaluation Commission, Executive Yuan, Taipei.

Reid CAM (2008) Coleoptera: Chrysomeloidea. Australian Faunal Directory, Australian Biological Resources Study, Canberra. http://environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/chrysomeloidea Accessed September 2011.

Rentz DCP (2006) Orthoptera. Australian Faunal Directory, Australian Biological Resources Study, Canberra. http://environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/orthoptera Accessed September 2011.

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2010) Hosts: a database of the world's lepidopteran host plants. Natural History Museum, London. http://www.nhm.ac.uk/research-curation/research/projects/hostplants/ Accessed August 2011.

Rohrbach KG, Beardsley JW Jr, German TL, Reimer NJ, Sanford WG (1988) Mealybug wilt, mealybugs and ants on pineapple. *Plant Disease* 72: 558–565.

Scott KJ, Brown BI, Chaplin GR, Wilcox ME, Bain JM (1982) The control of rotting and browning of litchi fruit by hot benomyl and plastic film. *Scientia Horticulturae* 16: 253–262.

Seino A (1980) Redescription of Chalioides kondonis Kondo and description of a new allied species from Taiwan (Lepidoptera: Psychidae). *Tinea* 10: 309–314.

Shao KT, Lee H, Lin YC (2011) TaiBNET catalogue of life in Taiwan. http://taibnet.sinica.edu.tw/home_eng.php Accessed 1 September 2011.

Shattuck SO (2008) Formicidae. Australian Faunal Directory, Australian Biological Resources Study, Canberra. http://environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/formicidae Accessed September 2011.

Smith BJ, Reid S, Ponder WF (2002) Superorder Pulmonata. Australian Faunal Directory, Australian Biological Resources Study, Canberra. http://environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/pulmonata Accessed September 2011.

Solovyev AV, Witt TJ (2009) The Limacodidae of Vietnam. *Entomofauna Supplement* 16: 33–320.

Spangler SM, Agnello AM (1991) Comstock mealybug: *Pseudococcus comstocki* (Kuwana). New York state integrated pest management program. http://www.nysipm.cornell.edu/ Accessed 29 July 2008.

Tai FL (1979) *Sylloge fungorum sinicorum.* Science Press, Academia Sinica, Peking.

Taiwan Tourism Bureau (2012) Climate. http://eng.taiwan.net.tw/m1.aspx?sNo=0002005 Accessed October 2012.

Takagi S (1990) The adult female. In Rosen D (ed) *Armored scale insects: their biology, natural enemies and control. Vol 4A* 5–20. Elsevier Science Publishers B.V., Amsterdam.

Tan S (1998) Analysis on the similarity of the structure of the litchi and longan pest communities. *Guangxi Science and Technology of Tropical Crops* 69: 4–10.

Tenbrink VL, Hara AH (1992) *Ischnaspis longirostris* (Signoret). Crop Knowledge Master. http://www.extento.hawaii.edu/Kbase/Crop/Type/i_longin.htm Accessed August 2011.

Thaung MM (2008) Pathologic and taxonomic analysis of leaf spot and tar spot diseases in a tropical dry to wet monsoon ecosystem of lowland Burma. *Australasian Plant Pathology* 37: 180–197.

Tran DV (2010) *Overview on tomato production and tomato varieties in Vietnam*. Hanoi Agricultural University, Hanoi.

Tsai JN, Hsieh WH (1998) Occurrence of litchi sour rot and characteristics of the pathogens *Geotrichum candidum* and *G. ludwigii*. *Plant Pathology Bulletin* 7: 10–18.

Tsai TJ, Chi H, . (2007) Temperature-dependent demography of *Supella longipalpa* (Blattodea: Blattellidae). *Journal of Medical Entomology* 44: 772–778.

Tseng YH (1982) Mites of the family Stigmaeidae of Taiwan with key to genera of the world (Acarina: Prostigmata). *NTU Phytopathologist and Entomologist* 9: 1–52.

Tseng YH, Lo PCK (1980) Tarsonemid mites (Acarina: Prostigmata) from Taiwan. *Plant Protection Bulletin* 22: 113–140.

Tzean SS, Hsien WH, Chang TT, Wu SH (2010a) *Fungal flora of Taiwan (ii): volume ii*. National Science Council and Department of Plant Pathology and Microbiology, National Taiwan University, Taiwan.

Tzean SS, Hsien WH, Chang TT, Wu SH (2010b) *Fungal flora of Taiwan (ii): volume iv*. National Science Council and Department of Plant Pathology and Microbiology, National Taiwan University, Taiwan.

Tzean SS, Hsien WH, Chang TT, Wu SH (2010c) *Fungal flora of Taiwan (ii): volume vi*. National Science Council and Department of Plant Pathology and Microbiology, National Taiwan University, Taiwan.

Tzean SS, Hsien WH, Chang TT, Wu SH (2010d) *Fungal flora of Taiwan (ii): volume vii*. National Science Council and Department of Plant Pathology and Microbiology, National Taiwan University, Taiwan.

UK CAB International (1980) *Armillariella mellea*. Distribution Maps of Plant Diseases No.143. http://www.cabi.org/dmpd/FullTextPDF/2005/20056500143.pdf Accessed October 2011.

UK CAB International (1991) *Phytophthora cinnamomi*. Distribution Maps of Plant Diseases No.302. http://www.cabi.org/dmpd/FullTextPDF/2004/20046500302.pdf Accessed September 2011.

USDA (2005) *Pests lists for fresh Litchi chinensis (lychee or litchi), Dimocarpus longan (longan), Mangifera indica (mango), Garcinia mangostana L. (mangosteen), Nephelium lappaceum L. (rambutan), and Ananas comosus (pineapple) fruit from Thailand*. United States Department of Agriculture, Raleigh.

USDA (2010) *Treatment Manual*. United States Department of Agriculture, USA.

USDA (2011) Importation of litchi and longan fruit from Vietnam into the Continental United States. *Federal Register* 76: 65985–65988.

USDA-APHIS (2008) Treatment Evaluation Document (TED). Policy Decision on the Treatment of Fruits and Vegetables under Quarantine 56. www.acfs.go.th/news/docs/APHIS-2007-0161-0004.doc Accessed May 2012.

Vacante V, Nucifora A (1986) A first list of the mites in citrus orchards in Italy. In Cavalloro R, Di Martino E (eds) *Integrated pest control in citrus groves: proceedings of the exports' meeting, Acireale, 26-29 March 1985* 177–188. Published for the Commission of the European Community by A A Balkema, Rotterdam.

Waite GK, Hwang JS (2002) Pests of litchi and longan. In Peña JE, Sharp JL, Wysoki M (eds) *Tropical fruit pests and pollinators: biology, economic importance, natural enemies and control* 331–359. CAB International, Wallingford.

WAL (2011) Plant Diseases Regulations 1989. Western Australia Legislation (WAL). http://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_1915_homepage.html Accessed 6 March 2012.

Wang CL, Lin FC (1997) *Pests of ornamental plants in Taiwan.* Havest Farm Magazine, Taiwan.

Watanabe T (1996) *Sporidesmium filiferum* from Tsukuba, Japan. *Mycoscience* 37: 367–369.

Watson GW (2005) Diaspididae. Arthropods of Economic Importance. http://nlbif.eti.uva.nl/bis/dispididae.php Accessed 2010.

Wen HC (1985) Field studies on melon fly (*Dacus cucurbitae*) and attractant experiment in Southern Taiwan. *Journal of Agricultural Research China* 34: 228–235.

Wen HC, Liou TD (2008) Insect pests and thier injuries on yuh-heh-bau litchi and effect of fruit bagging in Kao-Ping area of Taiwan. *Journal of Taiwan Agricultural Research* 57: 133–142.

Wen HC, Lu FM, Hao HH (1991) The investigation of insect and other animal pests on sponge gourd and seasonal occurrence in southern Taiwan. *Journal of Agricultural Research in China* 42: 204–208.

White IM, Elson-Harris MM (1992) *Fruit flies of economic significance: their identification and bionomics.* CAB International, Wallingford.

Williams DJ (2004) *Mealybugs of Southern Asia.* Natural History Museum and Southdene, Kuala Lumpur.

WTO (1995) Agreement on the application of sanitary and phytosanitary measures. World Trade Organization, Geneva.

Wu CS, Solovyev AV (2011) A review of the genus *Miresa* Walker in China (Lepidoptera: Limacodidae). *Journal of Insect Science* 11: 1–16.

Yeh GF (2004) *Taxonomy of the Family Scutelleridae of Taiwan (Hemiptera: Pentatomoidea).* PhD thesis, National Taiwan University, Taipei (in Chinese with English abstract).

Zhang ZQ, Hong XY, Fan QH (2010) *Xin Jie-Lu Centenary: progress in Chinese acarology.* Magnolia Press, Auckland.

Zhuang WY (2001) *Higher fungi of tropical China.* Mycotaxon Limited, Ithaca.