DRAFT IMPORT RISK ANALYSIS

AND

PROPOSED PHYTOSANITARY REQUIREMENTS

FOR THE IMPORTATION OF

BULK MAIZE {*Zea mays* L.}

FROM THE UNITED STATES OF AMERICA

March 1999

Australian Quarantine & Inspection Service
GPO Box 858
Canberra ACT 2601
AUSTRALIA

This draft Import Risk Analysis is being released for public comment. The release date is 19 March 1999. Comments sent to the address below are requested by 18 May 1999.

For additional copies of this publication, please contact:

Import Risk Analysis Secretariat
Plant Quarantine Policy Branch
Australian Quarantine & Inspection Service
GPO Box 858
Canberra ACT 2601
Telephone: (02) 6272 5094
Facsimile: (02) 6272 3307

AQIS
Protecting your way of life!

TABLE OF CONTENTS

LIST OF TABLES

Disclaimer

This draft IRA paper was prepared on the basis of the best information available at the time of writing on the pest and disease status of the commodity in question. Information relating to the identity of the respondent and the substance of the comments received in response to this document may be released to other respondents and to third parties unless a request for confidentiality is included in the response. Where a request for confidentiality is not made, a respondent will be taken to have consented to the release of information including the respondent's identity and the substance of the response for the purposes of the Information Privacy Principle 11 in section 14 of the *Privacy Act 1988*.

1. SUMMARY

An Import Risk Analysis, which includes Pest Risk Analysis of the phytosanitary risks and proposed management strategies, was conducted in response to an application to import bulk maize grain (*Zea mays L.*) from the United States of America (USA) for processing and use as animal feed in feedlots in Australia.

A number of pathogens, arthropod pests and weeds, likely to be associated with maize from the USA and capable of establishment in Australia via trade in bulk maize were identified with the potential to cause significant economic damage. A total of 16 pathogens, 14 arthropod pests and 78 weeds were considered to meet the definition of a quarantine pest for Australia. Risk management measures that may need to be adopted to meet Australia's appropriate level of phytosanitary protection and management options that could address the phytosanitary risks posed by the pests and diseases associated with maize in the USA are discussed.

This document provides the draft findings of the Risk Analysis Panel (RAP) to stakeholders for comment. Any comments received will be taken into account in reaching final recommendations.

2. INTRODUCTION

The Australian Quarantine and Inspection Service (AQIS) received an application in June 1997 for permission to import bulk maize from low risk areas of the USA to Australia for delivery through conventional transport systems to feedlots located inland for processing and use in animal feed.

Australia's current legislation prohibits the import of maize seed and grain except in the circumstances where AQIS issues import permits that may specify phytosanitary measures to effectively manage quarantine risks (Quarantine Proclamation 1998 made under the Quarantine Act 1908). Imports of maize seed for sowing include the requirement to grow imported seed in quarantine. Bulk imports of maize grain are currently permitted for processing in metropolitan areas at approved premises under quarantine supervision.

Previous pest risk analyses (Appendix 1) have identified a number of diseases/arthropod pests and weeds of quarantine concern to Australia, and have considered risk management options.

This draft IRA draws on previous work and new analysis to assess the risks to Australia of the proposal to import bulk maize [*Zea mays* L.] from the USA. An evaluation of possible risk management measures is provided with draft recommendations on managing the phytosanitary risks to meet Australia's appropriate level of quarantine protection.

2.1 IRA Process

In accordance with the International Standards for Phytosanitary Measures (ISPM) - Principles of Plant Quarantine as related to International Trade ISPM No.1 FAO, 1993; Guidelines for Pest Risk Analysis ISPM No. 2 FAO, 1993 and other standards developed by the Secretariat of the International Plant Protection Convention (IPPC) of the Food and Agriculture Organisation (FAO), for any application to import a new commodity from a new source, AQIS conducts an import risk analysis[Ψ] (IRA) on the phytosanitary risk to Australia posed by a proposed importation.

The primary purpose of an IRA is to identify quarantine pests[*] potentially associated with the commodity, to analyse their risk of introduction and establishment in Australia, and to evaluate candidate management options to mitigate such risks.

Ψ In this document the term import risk analysis includes the process of pest risk analysis as defined in the FAO Glossary of Phytosanitary Terms (FAO, 1997) and the consultation process as described in the AQIS Import Risk Analysis Process Handbook (1998).

* **FAO definition of quarantine pest (FAO Glossary of Phytosanitary Terms (FAO, 1997))**

The import access request has been considered using the non-routine IRA process outlined in *The AQIS Import Risk Analysis Process Handbook* (Anon 1998). Stakeholders are given opportunity to comment throughout the process.

In accordance with the non-routine process, a draft IRA (this document), covering technical issues related to disease and pest risk, risk management options and a preliminary view on which option would achieve Australia's appropriate level of protection is circulated to stakeholders for comment within 60 days. The World Trade Organisation (WTO) is notified of the release of this document. The document can also be viewed on the AQIS internet home page at http://www.aqis.gov.au/docs/plpolicy/plhome1.htm. After considering all technical issues including comments received, the RAP will finalise its recommendations.

The Panel's recommendations are submitted to the Executive Director, AQIS for consideration. The Executive Director may seek further advice from the RAP, if necessary, to assist in making his determination. The Executive Director must be satisfied that the IRA has been conducted in accordance with the agreed process, and that the determination on the proposal would maintain Australia's appropriate level of protection and otherwise accord with Australia's international rights and obligations under the World Trade Organisation – Sanitary and Phytosanitary Agreement (SPS Agreement).

The Executive Director's determination and the final IRA paper will be published. AQIS will advise the applicant and other stakeholders and arrange for notification in the AQIS Bulletin and on the AQIS Internet homepage.

If there are no appeals within 30 days from the date on which advice is sent to stakeholders the policy is adopted. Any stakeholder of the opinion that the process outlined in the Handbook has not been properly followed, including that the risk analysis failed to consider a significant body of relevant scientific or technical information, may appeal to the Director of Quarantine.

2.2 Scope of Analysis

The scope of this analysis, as requested by the proponent, is to assess the phytosanitary risks associated with the import of bulk maize originating from anywhere within the USA and to examine means to manage all significant phytosanitary risks offshore. The imported grain would be transported on arrival in Australia to rural areas for processing and use as animal feed without further intervention by AQIS.

The potential volume of imports is not known, but for the purposes of the IRA it was assumed to be at least tens of thousands of tonnes. Other factors that require consideration include soil, trash, weed seeds and admixtures of other grains (eg. barley, oats, millet, sorghum, soybean, wheat, rice, beans, sunflower, peanut, linseed and chickpea) that could be present in substantial quantities in bulk import lots.

There are existing arrangements for the importation of bulk grain for processing at the port of entry, or at approved premises in metropolitan areas. Approvals have included:

- steaming of whole grain at the port of entry to devitalise grain and any associated pests prior to transport to rural feedlots for use as animal feed,
- steam pelletisation at approved premises in metropolitan areas for stockfeed manufacture,
- destructive processing for extraction of amylopectin starch for industrial purposes,
- processing for manufacture into products such as corn chips.

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.

Subject to the existence of approved facilities and the ability to meet general quarantine conditions, AQIS will continue to approve applications to import maize for metropolitan processing on a case by case basis.

Although relevant information relating to these arrangements have been considered in this risk analysis they are not considered in detail in this report as they are outside the scope of the request submitted to AQIS.

There are a range of non-phytosanitary issues relevant to the importation of maize that fall outside the scope of the risk analysis and have not been addressed. Examples include pesticide residues or the potential economic impact of competition for the domestic producers from the importation of bulk maize grain. These issues are not directly relevant to the quarantine decision-making process but may be addressed, if necessary, by other areas of the Department of Agriculture, Fisheries and Forestry -Australia (AFFA).

2.3 Risk Analysis Panel

After consultation with stakeholders, it was determined that the IRA would follow the AQIS non-routine process. The members of the RAP are:

Dr Bill Roberts (Chair)
Chief Plant Protection Officer
AFFA

Dr Bob Ikin
Senior Manager
Plant Quarantine Policy Branch
Policy and International Division
AQIS

Mr Bill Magee
Senior Manager
Plant Quarantine Policy Branch
Policy and International Division
AQIS
(formerly, Program Manager, Grain Program, AQIS)

Mr Mev Connell
Member of the Advisory Committee to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Entomology
(formerly: Chief Executive Officer, Grain Elevators Board of Victoria;
Director, Australian Wheat Board; Assistant General Manager, Australian Wheat Board)

Professor John Irwin
Professor of Botany, University of Queensland
Director, Cooperative Research Centre for Tropical Plant Pathology

An *Issues Paper*, outlining the technical issues considered during the risk analysis, was circulated for comment on 6 July 1998 and is available on the AQIS Internet homepage.

2.4 Technical Working Groups

The RAP established four Technical Working Groups (TWGs) to examine issues relevant to the risk analysis. A RAP member chaired each TWG. The TWGs considered specific aspects of the IRA as described below.

1. **Pathogen TWG**: Analysis of quarantine pathogens associated with imports of bulk maize grain and assessment of the key disease risks associated with contamination of bulk shipments of maize with seeds of other agricultural plant species such as barley, oat, millet, sorghum, soybean and wheat.
2. **Arthropod TWG**: Analysis of insect, mite and mollusc pests potentially present in the bulk grain pathway (principally stored maize grain) in North America (Canada, USA and Mexico).
3. **Weeds TWG**: Analysis of quarantine weeds associated with proposed imports of bulk maize grain and consideration of different genotypes within species of common weeds already present in Australia. Herbicide resistant strains of weed species were included as potential quarantine species.
4. **Operations TWG**: Analysis of operational issues relevant to the importation of bulk maize grain from the USA, including risk management options consistent with the Australian Government policy, the SPS Agreement and relevant international standards, and operational procedures for implementation of management options recommended by the other TWGs.

Each TWG was given terms of reference outlined by the RAP and was asked to submit findings in the form of a technical report. The RAP drew upon these reports and discussions with the TWG in producing this draft IRA.

The TWG technical reports contain specific details of pests and diseases, both quarantine and non-regulated (non-quarantine), associated with the proposed importation of bulk maize sourced from the USA.

The TWGs were asked to draw upon all available information including international scientific literature and technical abstracts. The United States Department of Agriculture/Animal and Plant Health Inspection Service (USDA/APHIS) was asked to comment on a number of issues identified by the TWGs but the response was received after the deadline given to the groups to complete their reports. However, the RAP has considered comments from APHIS. The RAP considers that the information provided by APHIS is consistent with, and does not substantively alter, the findings of the TWG reports. Information provided by APHIS is discussed, where appropriate, in this report.

A public file, containing the draft IRA (this document), non-confidential stakeholder comments and technical documentation, has been established. This file includes the complete TWG reports. The public file is held at AQIS headquarters in Canberra and is available to stakeholders during business hours for perusal and copying. Contact information for making appointments to gain access to this public file is at page 2 of this document.

2.5 Australian maize industry

Maize (*Zea mays* L.) is the second most important crop in the world in terms of total food production. It is the most widely distributed cereal crop in the tropics and is important in the Americas, Africa and Asia. Most of the maize produced in temperate areas is used for livestock feed and industrial products. Maize produced in tropical countries is primarily for direct human consumption.

Maize production in Australia is concentrated in New South Wales and Queensland, with smaller amounts produced in Western Australia and Victoria. Most of the maize produced in Australia is consumed domestically. In some years, production does not meet consumption. Details of production and consumption are given below:

Maize Production and Consumption (000 tonnes) in Australia*						
Year	NSW	QLD	WA	VIC	Total Production	Domestic Consumption
1987-88	72.07	124.21	4.82	5.50	207.01	197.46
1988-89	78.27	132.11	4.04	1.45	215.86	77.49
1989-90	97.63	114.60	4.82	1.04	218.09	209.63
1990-91	90.64	94.93	5.39	2.02	192.98	175.25
1991-92	119.09	141.24	4.94	2.95	268.22	248.55
1992-93	107.87	74.57	12.95	2.76	198.15	175.47
1993-94	100.00	87.00	15.00	2.00	204.00	221.06
1994-95	145.34	79.89	11.38	5.14	241.74	297.05
1995-96	180.00	120.00	12.00	5.00	317.00	300.16
1996-97	244.00	110.00	12.00	5.00	371.00	324.90

* Australian Commodity Statistics, 1997. Australian Bureau of Agricultural and Resource Economics, Canberra. 346 pp.

Production has exceeded domestic consumption by an average of 20,700 tonnes per year over the ten years since 1997/98. However, maize is a preferred feed grain for some of the intensive livestock industries and there has been significant interest, in the import of bulk maize from overseas particularly in years when local supplies have been restricted by drought.

3. PATHOGEN RISK ANALYSIS

3.1 RISK IDENTIFICATION

The assessment found at least 428 potential pathogens associated with maize. These microorganisms were assessed for their presence in the USA and Australia, their ability to be transported with bulk maize grain, and their ability to cause significant losses. The assessments for the 373 microorganisms that have been reported in the USA are in Appendix 2, Table 14.1. The full lists are in Appendix 1 and Appendix 2 of the Pathogen TWG Report.

Of these pathogenic organisms, 55 were excluded as they have not been recorded in the USA. A further 202 were excluded because they either occur in Australia, or are unlikely to enter Australia in bulk maize, while 106 were not examined further as there was insufficient information available to form a judgement. Of the 65 pathogens that occur in the USA and not in Australia and can occur in the pathway, 49 were excluded as they are not reported to cause significant economic losses. Sixteen pathogens were identified that are present in the USA, can occur in the pathway, are not present in Australia, and are capable of causing significant economic damage.

Among the 106 pathogens with insufficient data for judgement there are several pathogens that have important pathogenic races. The status of their races in Australia is unknown, and these pathogens have not been examined further in this review. If further studies show that some races in the USA do not occur in Australia, then one or more of these pathogens may need to be considered for quarantine management. In addition, there are many quarantine pathogens of other crops potentially present in admixtures likely to be in bulk maize grain. Risk analyses have not been done on the 106 pathogens with insufficient data for judgement or quarantine pathogens of other crops potentially present in admixtures, as their risks would be managed by treatments to control the major maize pathogens. However, if untreated bulk maize of USA origin, containing admixtures of other crops, were moved into agricultural areas of Australia, there is significant risk that these other pathogens could be introduced.

Table 3.1 shows the sixteen organisms identified as potential quarantine pathogens, ranked on their likelihood of entering and causing loss in Australia. Ten of these pathogens have a higher overall risk. Some have the capacity to cause serious losses on commodities of substantially higher value than maize. For example, *Peronosclerospora sorghi* can attack sorghum while High Plains virus and wheat streak mosaic virus can damage wheat. Some of these high risk pathogens have relatively wide host ranges, extending to sorghum, wheat and naturalised grasses such as Johnson grass. In Australia there are many situations where feedlots and crops of maize, sorghum and wheat are in close proximity to each other. These issues need to be considered when developing possible management options.

Phymatotrichopsis omnivora, a minor pathogen of maize but serious on cotton and many other dicotyledons, was regarded as having a lower potential for establishment because it would be soil or trash- borne only. If an incursion did occur, however, and it became established, this pathogen would be extremely difficult to manage.

Cercospora zeae-maydis is a serious disease on maize in humid areas. However, it is regarded as less of an overall risk than some of the other fungal, bacterial and viral pathogens because it is likely to be only trash-borne and to be pathogenic only on maize.

It is useful to compare the 10 highest risk pathogens in Table 3.1 with the work of Phillips (1994). This study lists six of these pathogens as quarantine pathogens of concern but he did not include High Plains virus, *Sclerospora graminicola* and *Phymatotrichopsis omnivora*. Since this study, High Plains virus has been shown to be seed-borne, which justifies its present inclusion. The scope of the study did not cover pathogens that are not seed-borne. *S. graminicola* and *P. omnivora* are trash and soil-borne, and therefore could be present as contaminants in bulk maize.

The study included *Ustilago zeae, Sporisorium holci-sorghi* and *Claviceps gigantea*. The first two pathogens are present in Australia and the present risk analysis has not found sufficient data to justify their inclusion on the basis of possible differences in strains between the USA and Australia. However, further work may show that strains in Australia differ from those in the USA, which would change the risk potential classification of *U. zeae* and *S. holci-sorghi*, and justify Phillips' (1994) conclusion. Although *C. gigantea*, has not been recorded in the USA it has been recorded in parts of Mexico. Risk management measures would need to ensure that shipments of maize from the USA are not contaminated by maize from Mexico.

Table 3.1. A qualitative analysis of the relative[1] risk to Australia of 16 quarantine pathogens on maize grain from the USA

Pathogen (hosts)	*Disease Introduction Risks*	*Economic Damage Risks*	*Disease Management costs*	**Overall Risk**
Peronosclerospora sorghi (downy mildew of maize, sorghum)	*very high*	*high*	*high*	**very high**
Maize dwarf mosaic potyvirus (maize)	*extremely high*	*medium*	*medium to high*	**high**
High Plains virus (maize, wheat)	*high*	*high*	*low to medium*	**medium to high**
Wheat streak mosaic rymovirus (WSMV) (maize, wheat)	*very high*	*high*	*low to medium*	**medium to high**
Sclerospora graminicola (maize, sorghum, pearl millet and many grasses)	*medium to high*	*high*	*medium*	**medium to high**
Phymatotrichopsis omnivora (Texas root rot of cotton and other dicotyledonous plants)	*medium*	*high*	*medium*	**medium**
Maize chlorotic mottle machlomovirus (maize)	*very high*	*low to medium*	*low*	**medium**
Cercospora zeae-maydis (gray leaf spot of maize)	*high*	*low to medium*	*low to medium*	**medium**
Pantoea stewartii subsp. *stewartii* (Stewart's wilt of sweet corn)	*medium to high*	*medium*	*low to medium*	**medium**
Clavibacter michiganensis subsp. *nebraskensis* (Goss's bacterial wilt of maize)	*high*	*low*	*low to medium*	**medium**
Heterodera zeae (maize cyst nematode)	*low*	*low*	*low*	**low**
Ustilaginoidea virens (false smut of maize)	*low to medium*	*low*	*extremely low*	**low**
Dolichodorus heterocephalus (Awl nematode)	*very low*	*very low*	*very low*	**very low**
Hoplolaimus columbus (lance nematode)	*very low*	*very low*	*very low*	**very low**
Longidorus breviannulatus (needle nematode)	*very low*	*very low*	*very low*	**very low**
Pratylenchus scribneri (root lesion nematode)	*very low*	*very low*	*very low*	**very low**

A summary of the important features of three of the high risk pathogens (*Peronosclerospora sorghi*, High Plains virus and Wheat streak mosaic rymovirus) follows, to illustrate the range of issues that arise in relation to quarantine pests.

3.1.1 *Peronosclerospora sorghi*

Peronosclerospora sorghi, the cause of sorghum downy mildew, presents one of the greatest quarantine risks to the Australian grains industry from the importation of bulk maize from the USA. The disease was first reported in the USA in Texas in 1961 (Keyes *et al.*, 1964). By the early

[1] The risk estimates are relative to other pathogens in this table and are based on the collective judgement of the TWG members

1970's it had reached the corn belt in the Ohio River Valley in Indiana and Illinios (Frederiksen, 1980).

There is recent evidence that *P. sorghi* consists of more than one species with some strains that occur on maize now recognised as a separate species, *P. zeae*. Further work is needed to determine the distribution of this species (Jeger *et al*., 1998). Until the situation in the USA is better defined, the strains have been considered as one species.

In response to a request for information from the RAP, APHIS cited a paper by Shivas (1989) in which this pathogen was recorded in Australia. This was based on a single doubtful record (Tweedie 1970) that Ramsey and Jones (1988), after examining a herbarium specimen (Herb IMI 147292), considered to be *P. maydis* not *P. sorghi*. In view of this, the RAP determined that it was valid to consider *P. sorghi* absent from Australia.

The risks of introducing *Peronosclerospora sorghi* into Australia through bulk maize grain imports are summarised as follows:

- *P. sorghi* is in the pathway (maize seed, sorghum admixtures, trash or soil). It is likely to cause serious economic losses if introduced into Australia, particularly in grain sorghum, other *Sorghum* spp., sweet corn, maize, *Panicum* spp. and *Pennisetum* spp. The gross value of Australian sorghum in 1996/97 was $225 million, and maize, $75 million.
- *P. sorghi* is seed-borne and can also be carried in trash and soil.
- *P. sorghi* is widely distributed in the USA from southern Texas to central Illinios, where it was reported on sweet corn in 1990 (Pataky and Pataky, 1990). It can infect wild sorghums and it would be expected to produce oospores in systemically infected maize (Bigeriwa *et al*., 1998) that could form a pathway for seed transmission. Thus it would be difficult to source from maize-producing areas in the USA that are free of *P. sorghi.*
- Many feedlots in Australia are in agricultural areas where maize and sorghum are grown. If untreated imported grain is transported to such feedlots, *P. sorghi* could be introduced through spillage of grain, soil or trash present in the bulk import. If spillage occurred, oospores of *P. sorghi* could be dispersed by wind. The wide distribution of Johnson grass in northern Australia would provide a perennial source of susceptible host material.
- The systemic nature of *P. sorghi* could mean that it would remain undetected for a considerable period of time, particularly in an uneconomic and widespread host such as Johnson grass. Thus the pathogen could spread widely before being detected reducing the likelihood of successful eradication.

3.1.2 High Plains virus (HPV)

HPV was first recognised in 1993 in the western plains of the USA in maize. The virus is transmitted between plants by the eriophyid mite *Aceria tosichella*, and can be lethal to maize, wheat, barley and other grasses.

The disease is known to be seed-transmitted, and can be recognised by the presence of a protein that is specific to HPV infection.

HPV has been positively identified in 10 States of the USA, from eastern Nebraska to western Idaho, and from Montana and South Dakota to the Texas panhandle. It has also been identified from sweet corn samples from Florida. Genetic variability exists in maize reactions to HPV but this variability has not yet been characterised (Marcon *et al*. 1997).

Because HPV is only a relatively recently discovered virus (1993), there is still much to learn about its aetiology, distribution and management. Importantly, diagnostic tools have now been developed which will allow determination of its distribution and further clarification of its economic significance. This pathogen is regarded as having a very high risk to the Australian grains industry because:

- HPV is seed-borne and seed-transmitted in maize.
- It can cause yield losses of up to 75%.
- The disease also affects wheat and barley and thus must be regarded as a major threat to the $5 billion Australian wheat industry.

Devitalisation of the seed by grinding should be an effective management strategy for this pathogen, since there is no evidence it is capable of being mechanically transmitted.

3.1.3 Wheat streak mosaic virus (WSMV)

WSMV causes a serious disease of wheat, particularly in the Great Plains region, where annual losses up to 2% occur (Christian, 1993) and local losses can be 100% (McNeil *et al.*, 1996). WSMV is both seed-borne and seed-transmitted, and is transmitted by the wheat curl mite *Aceria tosichella*. High Plains virus is often found in association with WSMV, not surprisingly since they share a common vector. WSMV has also been found along with maize dwarf mozaic virus in the same maize plant (Hill *et al*., 1974), and is seed-transmitted in maize.

WSMV has a relatively broad host range, encompassing many plants in the grass family. It infects wheat, barley, oats, maize and millets (*Panicum*, *Setaria* and *Echinochloa* spp.). It is the type member of the rymovirus group, whose members are all mite transmitted.

WSMV was first recorded in 1932 (McKinney, 1937). There is considerable molecular diversity in the virus (McNeil, 1996), and it is thought molecular groups may correlate with host adaptation.

WSMV causes a serious disease in large areas of the USA and is seed-transmitted in maize. Its entry and establishment in Australia would pose a greater national economic risk to the $5 billion wheat industry than to maize. In maize, it could also be expected to cause substantial losses but with a less significant national impact. Devitalisation of all seed should be an effective management strategy for this virus.

3.2 DISEASE RISK MANAGEMENT OPTIONS

Evans *et al.* (1996) concluded that any spillage during transport to feedlots in Australia could be readily contained. However, it is evident from previous experience that spillage of grain and associated admixtures, soil and trash, and the discharge of dust into the air during loading, transport, unloading, storage prior to processing of grain, and in the event of processing plant breakdowns, are extremely difficult to control. Such spillage and discharge could provide opportunities for the establishment of pathogens.

Three recent incursions of quarantine pests show that it is difficult if not impossible to eradicate a pathogen once it has established:

- A major campaign in Western Australia failed to eradicate *Colletotrichum gloeosporioides*, the cause of anthracnose of lupins.
- Efforts to prevent the spread of *Ascochyta rabiei* within chickpea-growing areas of eastern Australia have failed and a widespread epidemic of blight developed in 1998.
- *Sphacelia sorghi*, causing ergot of sorghum, spread rapidly throughout sorghum growing areas in 1996, making eradication impossible.

Options for managing the risk of entry of quarantine pathogens are sourcing grain from pest-free areas, removal of soil and trash, devitalising seed by grinding, and pasteurising by heat.

From assessment of the published literature, it may be possible to source seed from pathogen-free areas for each of the pathogens listed in Table 3.1. However, there is a wide distribution across the USA for these pathogens when considered as a group, eg. humid areas in the southeastern USA for *Cercospora zeae-maydis* and arid regions in the southwestern USA for *Phymatotrichopsis omnivora*. The distribution of *Peronosclerospora sorghi* overlaps with *Phymatotrichopsis omnivora,* but would appear to extend further north to central Illinois. The bacterial pathogens *Pantoea stewartii* and *Clavibacter michiganensis* have a wider distribution, extending into northern USA. It is, therefore, unlikely that maize grain could be sourced from areas free of all of the quarantine pathogens contained in Table 3.1. Nevertheless, area freedom represents one possible risk management option if it can be adequately demonstrated that growing areas are free of diseases.

Devitalisation of maize seed by grinding would be an effective strategy to prevent entry and establishment of the four viral diseases. However, this strategy alone would not be fully effective for management of quarantine bacterial and fungal pathogens associated with maize grain, which would be expected to largely survive mechanical processing.

Setting maximum levels for trash, soil and admixtures may not effectively manage the risk for trash- and soil-borne pathogens, since substantial quantities of these materials are likely to be present in bulk imports. Oospores of *Peronosclerospora sorghi* would be present in contaminated soil at levels of 1–95 propagules per gram and soil may be present, even in Grade 1 maize, at a level of up to 2%. Thus, there is a clear risk that soil or trash could provide a viable avenue for entry and establishment of pathogens such as *Peronosclerospora sorghi*, *Cercospora zeae-maydis, Sclerospora graminicola*, *Phymatotrichopsis omnivora.*

Treatment of grain to kill possible quarantine pathogens on maize seed, soil, trash and other seed admixtures, appears to be the only suitable strategy for managing all pathogen risks. From the available data, heat treatment would appear to be the most effective mechanism. Work associated with grain imports in 1995 established treatment conditions that met quarantine requirements for a number of specific shipments. The RAP considered that further work would be needed to optimise a heat treatment effective against all quarantine pathogens while maintaining grain quality for routine imports of bulk maize.

Although the RAP considered that heat treatment could satisfactorily manage the quarantine risks any treatment that provided a high degree of reliability that all quarantine pathogens were killed would be acceptable. Choice of a suitable treatment would need to consider the risks posed by seed admixtures, trash and soil. However, treatments such as heat would manage all quarantine pathogens including those associated with admixtures. Treatment could be done either at the port of entry to Australia or off shore. If treatment is off shore, procedures will be needed to prevent re-infection. Depending on the point of treatment, particular issues that need to be considered include:

- Cleanliness of rail cars used to freight the sourced bulk maize in the USA. Spores of the Karnal bunt fungus (*Tilletia indica*) and other pathogens could be present in freight cars used to transport the bulk maize.
- Cleanliness of handling and loading equipment.
- Cleanliness of ship holds used to transport the bulk maize.

The full report of the Pathogen TWG is available on the AQIS Public File. This report includes the world list of maize pathogens, the preliminary assessment of the risk from these pathogens, and other important quarantine pathogens that may be introduced as admixtures.

4. ARTHROPOD PEST RISK ANALYSIS

4.1 RISK IDENTIFICATION

The arthropod pest risk analysis covered potential insect, mite and mollusc pests present in the grain after harvest (principally stored maize grain) in North America (Canada, USA, and Mexico). Insect, mite and mollusc pests of the plant, associated with organs such as stems, leaves and roots, were not considered in the analysis. This was due to the different environments present between field and storage, and the fact that very few pests are capable of surviving in both environments. Those species that do exist in both field and storage environments were included in the analysis. Also included in the analysis are 19 arthropod pests identified by the Pathogen TWG which are present in North America and are known to vector maize diseases.

Due to the nature of trade in grain between Canada, USA, and Mexico, and the fact that common railcars and transport are used between all three countries, arthropod pests of stored maize grain from North America as a whole have been included in the analysis. In addition, the use of common railcars and storage facilities in North America increases the likelihood of admixture of other grain commodities. For this reason, common pests of possible admixture commodities have also been included. The risk analysis process took into account factors such as the biology, host range, distribution, entry potential, establishment potential, spread potential and economic damage potential of pests capable of feeding and breeding on stored grains in North America and Australia. Species and genera considered, their distribution in North America and Australia, and their quarantine status in Australia are listed in Appendix 2, Table 14.2. Table 4.1 shows quarantine pests for Australia with a significant risk of being associated with bulk maize grain from the USA.

4.1.1 Insects

Pest species identified ranged from little known pests of limited worldwide distribution, through to pests such as *Prostephanus truncatus* and some *Trogoderma* species. As well as being pests associated with grain, all have the potential of establishing in natural habitats. Comments have been made in the data sheets (Arthropod pests TWG Report, Appendix 1) as to some possible adverse consequences that introduction of these pests may have to the natural environment. Once established in natural habitats, official control and eradication is likely to be difficult or impossible to accomplish.

Information on the status and distribution of important insect pests of stored grain is relatively reliable both in North America and in Australia, allowing a reasonable comparison to be made between the faunas of Australia and the USA in order to identify the quarantine pests. However, in comparison, knowledge of many mould-feeding and minor genera is limited. Insufficient information is available to ascertain if such species known to occur in North America are present in Australia. Some mould feeders can survive for substantial periods in clean, dry grain but are unlikely to be able to feed or reproduce in it; these species were included in the analysis.

A wide range of incidental insects can also be harvested along with grain. These form a sample of the local fauna and may include many species not found in Australia. The likely species involved are impossible to predict. Most of these incidental insects are unlikely to survive for significant periods in grain in storage, especially if it is clean with minimal admixture. No attempt was made to assess risks associated with parasites or predators that can be associated with pest species. Nevertheless, measures that effectively control arthropod pest species can be expected to control any species associated with them.

Table 4.1: Quarantine pests for Australia with a significant risk of being associated with bulk maize grain from the USA

a: Pests that are capable of breeding in stored grain

Cathartus quadricollis (Guérin-Méneville, 1829) [Coleoptera : Silvanidae]

Caulophilus oryzae (Gyllenhal, 1838) [Coleoptera : Curculionidae]

Cryptolestes turcicus (Grouvelle, 1876) [Coleoptera : Laemophloeidae]

Cynaeus angustus (Le Conte, 1852) [Coleoptera : Tenebrionidae]

Pharaxanotha kirschi Reitter, 1875 [Coleoptera : Languriidae]

Prostephanus truncatus (Horn, 1878) [Coleoptera : Bostrichidae]

Tribolium audax Halstead, 1969 [Coleoptera : Tenebrionidae]

Tribolium brevicornis (LeConte, 1859) [Coleoptera : Tenebrionidae]

Tribolium destructor Uyttenboogaart, 1933 [Coleoptera : Tenebrionidae]

Tribolium madens (Charpentier, 1825) [Coleoptera : Tenebrionidae]

Trogoderma glabrum (Herbst, 1783) [Coleoptera : Dermestidae]

Trogoderma inclusum LeConte, 1854 [Coleoptera : Dermestidae]

Trogoderma ornatum (Say, 1825) [Coleoptera : Dermestidae]

Trogoderma variabile Ballion 1878 [Coleoptera : Dermestidae]

b: Pests associated with damp maize grain from the USA

Glischrochilus fasciatus (Olivier, 1790) [Coleoptera : Nitidulidae]

Glischrochilus quadrisignatus (Say, 1835) [Coleoptera : Nitidulidae]

c: Pests associated with infestable pulses

Callosobruchus chinensis (Linnaeus 1758) [Coleoptera : Bruchidae]

Zabrotes subfasciatus (Boheman 1833) [Coleoptera : Bruchidae]

d: Additional pests of quarantine concern for Australia

Trogoderma granarium Everts, 1898 [Coleoptera : Dermestidae]

Most major economic pests of stored grain with the exception of those identified in Table 4.1, are common to both North America and Australia. While these species may be common genotypes of a given species may be different in either continent. Strains in one place may be more resistant to pesticides and fumigants than elsewhere. Importation of such strains could cause problems with using control treatments. Currently, there is no information indicating that strains of major storage insects present in the USA and Canada are significantly more tolerant to pest control treatments than those known to occur in Australia. However, this may be due to lack of data as survey results in the USA and Canada, particularly for phosphine resistance, are rudimentary. In the absence of data and because of the widespread use of phosphine fumigation in the USA it should be assumed that some degree of phosphine resistance is likely to be present, at least in common stored product pests. Dosages will need to be targeted accordingly if phosphine is chosen as a disinfestant.

An additional pest, *Trogoderma granarium* Everts, the khapra beetle, was identified as being of concern to Australia (Table 4.1d). *T. granarium* is not established in North America and is a legislated pest in the USA. However, it is possible for this species to be present in ships used for grain transport and interceptions have been recorded via this pathway.

4.1.2 Mites

Our knowledge of the Australian mite fauna, native and exotic, associated with stored products is incomplete and no recent, in-depth surveys have been undertaken. It is not possible to assert that a given mite, not currently recorded here, is not present in Australia. No mite species listed by the USDA key (Smiley, 1991) and not recorded to date in Australia is known to be significantly destructive to well-stored grain. No assessment can be made as to the potential environmental impact of mites likely to be associated with stored maize, though some are likely to become established outside of grain stores, if not already present. However, well-managed clean, dry grain is unlikely to contain significant numbers of mites.

4.1.3 Molluscs

No specific references were found concerning snails as an agronomic problem associated with trade in maize grain in the USA and Canada. Snails may however be harvested as an incidental contaminant. As such they are likely to form a sample of the local fauna and may include species not found in Australia. Information does not appear to be available as to the ability of such species to survive in stored grain. Experience with the importation of bulk maize grain from the USA in 1995 indicates that the risk of importation of molluscs is low.

4.2 ARTHROPOD RISK MANAGEMENT OPTIONS

4.2.1 Grain quality

Many insect species find it much easier to become established in grain consignments containing admixture and damaged grains. Risk of infestation increases with the decline in grain quality, measured in terms of its physical condition (eg. % broken, immature or mouldy grains), increase in temperature and moisture content, and increase in admixture of trash and other material. Risk of importation of species identified as of quarantine concern to Australia, with the exception of *Caulophilus oryzae* and *Prostephanus truncatus* that attack whole grains, would be reduced if only high grade grain, in good condition with minimal admixture, was imported. Grain moisture content should be less than 14%, independent of grade. A number of species including *C. oryzae* and *Glischrochilus* spp., are adversely affected by low moisture content. Complete removal of admixture of pulses from maize reduces the risk of species from Table 4.1c being imported to negligible levels.

Sieving and grain cleaning will remove most snails and other incidental contaminants. It may however be difficult to remove contaminants that are of similar size and density to maize grains, such as pulses.

If fumigation is used as a risk management measure then grain quality could a significant issue. Lower grades of maize are notoriously difficult to fumigate as regions of bulk cargo can be very high in trash and fines – this material tends to segregate during handling and transport of the grain and forms pockets and layers through which fumigants may have difficulty passing. This results in non-uniform distribution of gas and an increased risk of fumigant survivors. These problems are compounded if fumigation is undertaken in-ship (see later discussion on fumigation). Clean grain is much easier to fumigate properly.

4.2.2 Selection of grain from areas free of pests (Area Freedom)

Several species identified as of quarantine concern to Australia appear to have restricted distributions in the USA. *Caulophilus oryzae*, *Prostephanus truncatus* and *Cathartus quadricollis* appear to be restricted to southern States with *P. truncatus* and *C. quadricollis* at least being much more widely distributed in Mexico. If it is possible to guarantee the source of grain, obtaining it from more northerly areas will reduce the risk of importation of these species, although it will not completely eliminate the risk. Other species identified as of quarantine concern however, appear to be widely distributed and it will not be possible to identify maize producing regions free of these pests. In general, however, infestation pressure declines the further north the grain growing areas are. If maize is to be sourced using the principle of "Area Freedom", this will require detection, monitoring and delimiting surveys for quarantine pests to be carried out annually, as well as the dedication and monitoring of rail cars. This is not normal practice in the USA.

4.2.3 Prevention of infestation during transportation, storage and handling

A number of species identified as of quarantine concern, notably *Cryptolestes turcicus*, and the *Tribolium* and *Trogoderma* species, are not host specific and can be pests infesting residues present in grain handling systems. Such species can infest maize grain when handled through contaminated facilities. Use of well managed handling and transportation systems will reduce this risk. Fumigation of these facilities would provide control of insects but this is a non-residual treatment and will not confer protection of the grain during subsequent handling and transportation.

Ships used for the importation of bulk maize need to be 'fit for purpose'. Vessels can become infested with insects of quarantine concern from previous cargoes and not necessarily only those associated with maize. This could include species that are not established in North America including the khapra beetle, *Trogoderma granarium*. Prior to loading grain, ships must be clean and free of infestation, at least to the standard expected of vessels that handle Australian grain exports. This includes not only the hold, but all other areas of the vessel including crew quarters, engine room and related areas from which infestation could arise.

4.2.4 Fumigation

There is little or no data available on the effects of fumigants, contact insecticides or other control measures on most of the pests identified as of quarantine concern. Nonetheless, most are unlikely to be more tolerant than *Tribolium castaneum* with methyl bromide (Bond 1989), *Sitophilus oryzae* with phosphine (National Working Party on Grain Protection 1997) or the lesser grain borer, *Rhyzopertha domininca* with heat (Banks and Fields 1995), these being the most tolerant pests that the Australian dosage rates are aimed at. Exceptions are likely to be *Trogoderma* species, as larvae in diapause, which are exceptionally tolerant of methyl bromide (Rees and Banks 1998), and also species in the family Bruchidae, which can be exceptionally tolerant of phosphine and many contact insecticides (National Working Party on Grain Protection 1997). The pesticide resistance status is unknown for all these pests from North America and may need to be investigated if fumigation is to be used as a primary risk management measure.

It is also noted that ship fumigation is an uncertain process and is most unlikely to be carried out to a standard required to give kill to a level expected for Australian quarantine purposes. It is extremely difficult to ensure adequate gas distribution in the hold or any other part of a ship, even if the ship is stationary. The problem is further compounded if any bulk commodity being fumigated contains a significant quantity of fines, trash and admixture; a common component even of high grades of maize.

The normal practice used by the USA for grain shipments is for grain to be treated with phosphine at US label rates as an in-ship treatment for the duration of the voyage. This methodology is not considered adequate for phytosanitary purposes due to difficulties in obtaining and assessing appropriate distribution of gas.

4.2.5 Devitalising treatments

Processing maize prior to shipment can reduce the risk of importing the identified pest species of quarantine concern. The risk of importing species, eg. *Caulophilus oryzae* and *Prostephanus truncatus* that require whole grain, can be much reduced by milling the grain and other processing treatments such as steam pelleting. Other species present may be eliminated by the insecticidal nature of such processing.

Heat can be used for the processing or devitalisation of grain and may be insecticidal. Temperatures above 50°C are insecticidal, and become rapidly more insecticidal as temperatures increase above this. All storage pests are killed by a few seconds exposure to either wet or dry heat of 65°C (Field 1992, Banks 1998). Time allowance needs to be made for the heat to penetrate the grain kernel to this temperature.

However, after treatment, some species identified as of quarantine concern could reinfest, notably *Cryptolestes turcicus,* and the *Tribolium* and *Trogoderma* species. Therefore, if this option is adopted, continued phytosanitary security to prevent reinfestation must be assured.

The full report of the Arthropod TWG is available on the AQIS Public File. Data sheets for these insects detailing their biological properties, extent of host range, potential impact and difficulty of detection are given in the TWG report (Appendix 1 - Biological Assessment of Arthropod Pests Associated with Stored Maize Grain and Admixture Grain Commodities and Arthropod Pests Known to Vector Maize Diseases in North America).

5. WEED RISK ANALYSIS

5.1 RISK IDENTIFICATION

5.1.1 Definition of quarantine weeds

To be classified as a quarantine pest, a weed taxon needs to meet the IPPC definition (Section 2). Being under "official control" in this context is taken to mean that they are on a published list of Declared or Noxious Plants or Prohibited Plants and are subject to control by or under the legislated instruction of a State or local government body in some part of Australia.

The matter is complicated by the presence of different genotypes within many species of common weeds. Is the possible introduction of a new genotype sufficient reason for excluding further entry of an already widely established species? The approach taken by the Weed TWG, and supported by the panel, was to consider weeds present in both the USA and Australia as non-quarantine pests unless there are particular and identifiable genotypes of the weed in the USA that are not known to be present in Australia and which could be expected to be of economic importance if established here (eg. herbicide resistant strains).

Appendix 2, Table 14.3 lists the weed species recorded in fields of maize, sorghum and soybean in the USA and species recorded as contaminants in maize exported from the USA. Weed species found in sorghum and soybean crops are included, not only because they are likely to share the same fields as part of a rotational cropping system, but also share post-harvest facilities. There is a high chance of cross contamination among these species with maize. The species are mostly common summer weeds found in the USA. However, winter weeds, and other species, found recorded as contaminants in US maize exports to other countries (Anon 1994), are also listed. Quarantine weed pests are listed in Table 5.1.

5.1.2 Weed risk assessment

AQIS uses a Weed Risk Assessment (WRA) system to assess the weed potential of new plant species for which applications for importation into Australia have been lodged. The system is a question based scoring system. The information required to input into the system includes knowledge of the species' ability to adapt to Australian climates, noxious and beneficial characteristics, and the ability to spread, reproduce and persist.

Species from Appendix 2, Table 14.3 not recorded in Australia were assessed using the WRA system confirming that they have a high potential to establish, spread and become weeds in Australia, both in agricultural and environmental contexts.

In summary the risk analysis identified 78 weeds of quarantine concern to Australia that have a significant risk of being associated with bulk maize grain from the USA (Table 5.1). A number of these are herbicide resistant variants of species present in Australia.

Data sheets for these pests detailing their biological properties, potential impact, and entry and establishment potential are given in Appendix 1 of the Weed TWG report which is available from the public file.

Table 5.1. Quarantine pest weed species associated with bulk maize grain imported from the USA.

Weed	QUARANTINE STATUS or WRA score*
Abutilon theophrasti (herbicide resistant)	Q
Acanthospermum hispidum	Q
Aeschynomene virginica	17
Amaranthus arenicola	13
Amaranthus chlorostachys	14
Amaranthus hybridus (triazine resistant)	Q
Amaranthus palmeri (herbicide resistant)	11
Amaranthus retroflexus (triazine resistant)	Q
Amaranthus *rudis* (triazine resistance)	14
Amaranthus tamariscinus	10
Ambrosia artemisiifolia	Q
Ambrosia trifida	Q
Ampelamus albidus	15
Apocynum cannabinum	13
Asclepias syriaca	Q
Berteroa incana	14
Bidens aurea	Q
Brachiaria platyphylla	15
Brassica japonica	10
Bromus tectorum	Q
Brunnichia ovata	13
Cenchrus incertus	Q
Cenchrus longispinus	Q
Chenopodium album (atrazine resistant)	Q
Cirsium arvense	Q
Cocculus carolinus	6
Conringia orientalis	Q
Convolvulus arvensis (herbicide resistant)	Q
Cyperus esculentus	Q
Cyperus rotundus	Q
Datura inoxia	Q
Datura inoxia (resistant to ALS herbicides)	Q
Datura stramonium	Q
Daucus carota	Q

Weed	QUARANTINE STATUS or WRA score*
Echinochloa crus-galli (herbicide resistant)	Q
Equisetum arvense	Q
Eriochloa villosa	17
Eupatorium capillifolium	19
Euphorbia supina	Q
Helianthus annuus (herbicide resistant)	Q
Ipomoea hederacea var. *integriuscula*	Q
Ipomoea lacunosa	12
Ipomoea purpurea	Q
Ipomoea turbinata	10
Jacquemontia tamnifolia	Q
Kochia scoparia	Q
Lolium multiflorum (herbicide resistant)	Q
Muhlenbergia frondosa	14
Panicum capillare (herbicide resistant)	Q
Panicum dichotomiflorum	16
Panicum fasciculatum var. *reticulatum*	Q
Panicum ramosum	14
Panicum texanum	16
Polygonum arviculare	Q
Polygonum convolvulus	Q
Polygonum lapathifolium	Q
Polygonum pensylvanicum	Q
Raphanus raphanistrum	Q
Rubus allegheniensis	19
Rubus fruticosus	Q
Salsola collina	17
Salsola iberica	17
Salsola kali	Q
Salvia reflexa	Q
Senecio vulgaris	Q
Senna obtusifolia	Q
Setaria faberi	Q
Setaria lutescens (herbicide resistant)	18
Sicyos angulatus	18
Solanum ptychanthum	13
Sorghum x almum	Q
Sorghum halepense	Q
Striga asiatica	Q
Verbesina encelioides	Q
Xanthium pensylvanicum	Q
Xanthium spinosum	Q
Xanthium strumarium	Q
Xanthium strumarium. (resistant to imidazolinone)	Q

* Weed Risk Assessments (WRA) were done for species (in boldface) not known to be present in Australia and not yet prohibited. Species with scores in excess of 5 are likely to become weeds in Australia and are rejected by AQIS. The remaining species (Q) are prohibited under Commonwealth legislation, noxious under State legislation or have herbicide resistant variants in the USA.

5.1.3 Risk assessment of herbicide resistant maize in bulk maize imported from the USA

The use of herbicide resistant maize varieties allows more effective weed control in crops by allowing application of a wider range of post-emergence herbicides without damaging the crop.

A number of maize hybrids with resistance to herbicides such as imidazolinone, sethoxydim and glufosinate ammonium, produced by Pioneer, ICI, and Cargill have been widely commercialised in the USA (Table 5.2). There is a significant risk that maize grain imports from the USA will contain a component of herbicide resistant varieties. Various activities during loading, transportation and processing of imported maize have the potential to unintentionally release genetically modified maize into the environment.

Table 5.2. Genetically modified herbicide resistant maize lines commercialised in the USA

Maize lines resistant to:	Gene modification technique	Status in Australia
Acetyl coenzyme A carboxylase (ACCase) group: sethoxydim, haloxyfop, cycloxydim	mutation, inbred lines developed *in vitro* selection and crossing with other lines to develop hybrid	not yet present
Glufosinate ammonium	gene transformation	not yet present
Imidazolinone groups: imazethapyr, imazapyr, imazaquin, clomazone	point mutation, inbred lines developed *in vitro* selection and crossing with other lines	not yet present

The risk of herbicide resistant maize becoming weedy

Although maize carrying herbicide resistant genes could germinate along the roadside, the chance of survival until the reproductive stage is low. Generally, maize appears as a volunteer in some fields and roadsides, but it has never been shown to become established and reproduce in the wild (Gould 1968). Maize is non-invasive in natural habitats and likely to be controlled by natural herbivores during early stages of growth. Shed pollen of maize can remain viable for 10-30 minutes (Coe *et al.* 1988). If viable pollen of herbicide resistant maize were to be transferred by wind to any receptive maize stigma within the 30 minute period of pollen viability, an escape of genetic material could take place. This potential transfer is very unlikely at a distance beyond 200 m. There is only a small chance that volunteer maize will survive until the flowering stage and transfer genes to other maize varieties.

Even if genes do escape into other maize varieties, the added characteristic of herbicide resistance would still not significantly increase weediness provided that none of the reproductive or growth characteristics were modified. Maize seed has little or no dormancy and loses germinability within 2 years under natural conditions and therefore does not develop a soil seed bank. If accidentally introduced into cropping systems, there is a risk of herbicide resistant volunteer maize persisting, particularly in soybean crops or in crop rotation systems (Young & Hart 1997, Vangessel *et al* 1996).

The risk of gene escape to wild relatives

No *Zea* species are either naturalised or recognised as weeds in Australia. However, there are wild relatives of maize imported from South America (Teosinte: *Euchlena mexicana*) whose distribution may overlap with that of cultivated maize. Teosinte is an ancient wild grass found in Mexico and Guatemala. Teosinte can be found in Queensland and Western Australia. Although teosinte has the ability to establish in the wild, it has no pronounced tendency to weediness (Gould, 1968). Cultivated maize and teosinte are sexually compatible and can produce fertile F1 hybrids. However, introgression between maize and teosinte rarely occurs naturally, probably because of the difference in flowering time. Related *Zea* species are geographically restricted and occur only in Mexico and Guatemala. There is low potential for interspecific gene flow to wild relatives to occur in Australia.

The importation of herbicide resistant maize in bulk feed grain for processing is therefore unlikely to present a significant risk to agricultural systems or the environment because it lacks other weedy characteristics, particularly the ability to naturalise in the wild. The risk of genes for herbicide resistance escaping from maize into agricultural and environmental areas is also low because sexually compatible species in Australia are rare.

5.1.4 Quarantine implications of *Striga asiatica* in the USA

Striga asiatica is the most serious root parasite of maize and other grass crops (including sorghum and sugarcane) in the world. Once established in an area it is extremely difficult (and expensive) to eradicate. Its seed size is very small (0.5x0.2 mm) and would be difficult to detect by normal sampling and analytical methods. The risk of it being imported into Australia with feed maize has been assessed.

The only *Striga* species present in Australia are 3 native species, *S. curviflora*, *S. multiflora* and *S. parviflora* (Hnatiuk 1990). *S. curviflora* and *S. parviflora* are major causes of concern in sugar cane in Queensland, where they are either called cane-killing weed or witchweed. *S. parviflora* has been recorded as a serious weed of maize crops in the Atherton tableland (Henderson 1984). *Striga asiatica* was previously reported from the North Kennedy Grazing District of Queensland (Hnatiuk 1990), but is no longer considered to be present in Queensland (Phillips 1994, Hucks L. Botanist, Queensland Herbarium, Brisbane Australia, Personal communication.) since the herbarium record was shown to be a misidentification.

Striga asiatica was first recorded in North Carolina in 1956 (Sand 1979), immediately triggering concerted efforts to limit its further spread and to eradicate it from the country; this program has continued over the last 48 years and is only now nearing completion.

The following advice was provided by Dr Robert Eplee, Senior Research Scientist and Director of the Raleigh Plant Protection Centre, North Carolina, USA (August 1998):

> "*Striga* has been under an intensive eradication program over the past years. All but about 10,000 acres of the original 435,000 infested acres has been declared eradicated. On the remaining infested areas, reproduction (seed production) is denied through the use of herbicides. Without seed production, it would only be possible to 'export' *Striga* seeds with the movement of soil. Movement of soil out of a maize field is inconsistent with our machine harvest methods. Our protocol requires that a site meet a set of conditions, accumulated over at least three years, before eradication can be declared. Nearly all of the infested acreage falls into this category."

Although the risk of *Striga asiatica* being present as a contaminant species in maize imported from the USA is very low, maize grain should not be sourced from any area infested or previously infested with this weed.

5.2 WEED RISK MANAGEMENT OPTIONS

Weed risk identification and assessment confirmed the previous conclusion of Phillips (1994), Anon (1994) and Roberts *et al.* (1995) that bulk import of feed maize poses a significant risk of accidentally introducing a number of weed species into Australia. To reduce the risk to a manageable level, a number of phytosanitary management methods are reviewed (some of which have been proposed in the previous reviews of Roberts *et al* 1995, and Evans *et al* 1996).

5.2.1 Sourcing US maize from *Striga* free areas

Although it is concluded that the risk of exporting bulk grain contaminated by *Striga* is low, consignments still may require phytosanitary certification declaring that the consignment of maize is bulked from maize grown in *Striga* spp. free areas. Relevant information in support of this declaration could include the source of maize, and a current map of *Striga* infested or controlled areas.

5.2.2 Weed management in the field

To reduce weed contaminants, a specific weed management program may be recommended for maize growing areas destined for export to Australia. After black layer formation in maize seed, which indicates the crops have reached physiological maturity, it may be possible to apply the herbicides glyphosate plus 2,4-D or dicamba. Long term experiments have confirmed that the treatments can effectively control most late emergence perennial weed species. These species included *Apocynum cannabinum*, *Asclepias syriaca*, *Calystegia sepum*, *Ampelamus albidus*, *Sida* spp., *Sorghum halepense* and *Cynodon dactylon* (Carringer *et al*. 1980). If this control practice is applied to areas growing maize for export to Australia, the number of weed seed contaminants in maize grain could be significantly reduced.

5.2.3 Screening and scalping

According to previous reviews (Evans *et al.* 1996), maize shipments contained a smaller number of contaminants than other imported grain. One of the reasons was that the size of maize seed is larger than that of most weed species and has a smooth surface. Consequently, many weed seeds can be excluded by appropriate screening and scalping.

A number of seed cleaning treatments are available which can exclude weed seed of different size, shape, texture or density to maize. Theoretically, if an intensive cleaning technique is adopted, many, but not all, quarantine weed seeds should be excluded. However, the technique may be too expensive for low cost feed grain and a risk of introducing a significant number of new quarantine weed species into Australia would remain.

5.2.4 Seed Sampling Intensity

One risk management measure sometimes used in quarantine is to test or inspect the product at a particular sampling intensity that ensured that if no quarantine pests were found then the shipment met the quarantine requirements.

Statistical advice was sought on the appropriate representative sample size of bulk maize grain in which a nil tolerance for quarantine weed seeds could be imposed. After mechanical reduction of the composite sample and submitted sample, practical operational constraints restrict the working sample to a maximum of 50 kg. Although this sample size is quite large seed technologists could use appropriate screening techniques to assist in isolating weed contaminants before performing seed identification of any found. The statistical analysis indicated that even if no weed seeds were found in the 50 kg working sample, up to 70 weed seeds may be present in each tonne of maize grain (Roberts *et al*, 1995). Extrapolating from this, if the bulk grain consignment size is 50,000 tonnes, up to 3,500,000 weed seeds could be present.

It was concluded that an intensive sampling method for bulk grain shipments would be operationally difficult and costly to implement and would not provide sufficient assurance of the absence of quarantine weeds in a shipment.

5.2.5 Devitalisation treatments

Steam heat treatments

Preliminary studies indicated that steam treatment at 95-100°C for 12-15 minutes killed the following species: *Ambrosia trifida*, *Abutilon* spp., *Amaranthus* spp., *Circium arvense*, *Setaria italica*, *Sorghum bicolor*, *Glycine max*, *Triticum* sp., *Chenopodium* sp., *Avena sativa*, *Raphanus raphanistrum*, *Hordeum* sp., *Xanthium spinosum*, *Xanthium pungens*, *Secale cereale*, *Galium* sp., *Polygonum convolvulus*, *Brassica* spp., *Stellaria media*, *Spergula arvensis*, *Galeopsis bifida*, *Thlaspi arvense* and *Rapistrum rugosum* (Grain Taskforce file, 1995) .

Steam heat treatment of imported maize would manage the risk effectively, particularly if the treatment can be conducted at the port of entry or just prior to export, minimising the opportunities for post-treatment re-contamination. To optimise the temperature and time required to be effective for all weed species and admixtures, further work may be necessary. If the steam heat treatment is carried out at the point of export, additional operational requirements should include appropriate hygienic measures during the pre-entry handling process to avoid re-contamination.

Infrared energy management system

Infrared radiation converts to heat once an absorbent material is struck. When energy produced by the infrared radiation penetrates the material, it causes vibration of the constituent molecules, thus elevating the temperature. As opposed to microwave radiation, which is dependent to a large extent on sufficient moisture content in the material to be successful, infrared systems can effectively heat dry material. An infrared heat treatment facility for treatment of linseed has been approved by AQIS. Infrared heat has the potential to devitalise grain in a shorter time frame than steam heat treatment and may be less likely to damage grain but acceptance of this treatment method would require work to determine a suitable time and temperature regime that would ensure that weed seeds are devitalised.

Fumigation

Trials on devitalisation of maize using methyl bromide and chloropicrin were undertaken by CSIRO scientists as AQIS consultants in 1995 (Magee, W- personal communication). The results indicated that despite the very high dosage of methyl bromide used, all samples of maize maintained some germinability after treatments. After five times the dosage and twice the exposure period normally specified by AQIS for disinfestation of consignments, more than 10% of the treated maize germinated. Chloropicrin at 4 times the commercial dosage was also found to be ineffective in devitalisation of maize, reducing germination by only few percent.

Extrapolating from these results, many weed seeds are likely to survive these fumigation treatments, and that there would be practical difficulties in their use and chemical residue problems in the treated maize. Fumigation treatments are unlikely to be effective in killing weed contaminants in maize consignments.

5.2.6 Reducing the risk of leakage and spillage

The possibility of using stringent controls to prevent spillage of untreated grain in Australia during transport, storage and processing was considered. A previous review (Evans, *et al.* 1996) concluded that spillage of untreated maize grain from high risk sources, however minor, could be critical. The RAP agrees with this view.

The full report of the Weed TWG is available on the AQIS Public File. Data sheets for the quarantine weeds are given in that report.

6. ANALYSIS OF OPERATIONAL ISSUES

The analysis of the pathogen, arthropod and weed risks have all indicated that bulk maize would need to be treated to reduce the risk to a level that meets Australia's appropriate level of protection. This section discusses a range of operational issues related to the application of a suitable treatment and maintenance of the integrity of the maize after treatment.

6.1 USA CORN GRADES

In the USA corn is defined as "Grain that consists of 50 percent or more of whole kernels of shelled dent corn and/or shelled flint corn (*Zea mays* L.) and may contain not more than 10.0 percent of other grains under Federal Grain Inspection Service (FGIS) standards, established under the United States Grain Standards Act. This definition establishes a minimum specification but there are a range of specific grades defined by FGIS. For example, the maximum percentage foreign matter that can be present ranges from 2% in US Grade 1 to 7% in US Grade 5. The grade standards also specify the allowable limits of damaged kernels. The foreign material content has clear implications for the presence of other seed-borne pathogens on grain admixture and makes the overall assessment of risk difficult. Damaged grain may also be relevant depending on the reason for damage, which can include disease and other pest damage with implications for the phytosanitary risk.

Given the earlier conclusion that grain would need to rendered sterile and disinfected at the port of export in the USA, the likelihood of achieving this outcome is greater if a higher grade of corn is used, since a cleaner starting product provides greater confidence that the treatment will be effective. On the basis of USA Corn Grades and taking into account Australia's experience with previous shipments of maize from the USA, the RAP considers that Australia's grade specification for any future shipments of maize feedgrain should be US No. 2 or better. It is noted however that if the process used to treat the grain can be shown to be equally effective on other grades of corn then lower grades may be an acceptable alternative.

6.2 POST TREATMENT RISK MANAGEMENT OPTIONS

There are a number of operational issues related to maintenance of the integrity of treated maize from the point of treatment to arrival in Australia.

6.2.1 Inspection Agencies

The USA export grain industry is not regulated to the extent that the grain industry in Australia is, however the Federal Government provides an infrastructure for Government Certification of documented quality grades. There is an accreditation and qualification system for individuals, agencies and certification companies to maintain certification integrity.

The following Inspection Agencies are involved in inspection and certification of grain in the USA:

- APHIS, the organisation responsible for the issuance of phytosanitary certificates. Certificates are issued on the basis of FGIS inspections and sampling, and analysis of the samples by the Federal Seed Laboratory.
- FGIS. The role of FGIS and FGIS Agencies is primarily to maintain a recognised system of grading for commercial grain trading.
- State Departments of Agriculture. Many State Departments of Agriculture have a memorandum of understanding with APHIS. They conduct surveys for diseases in seed crops and specific pests and have a capacity to provide seed laboratory services.

The RAP considers that there is adequate infrastructure in the USA to provide certification on grain shipments. However, specific arrangements would need to be negotiated with appropriate agencies.

6.2.2 Inspection standards

Some members of the Australian Grain Mission 1995 expressed the view that hygiene and operational standards were poor at some USA elevators (Roberts *et al.* 1995 Report of Grain Mission). Elevators visited during that Mission confirmed that view. Unlike Australia, where hygiene standards are a mandatory condition, enforced by legislation, for the export of prescribed grains and prescribed goods, inspection and certification in the USA is based solely on inspection, sampling and analysis of the grain lot. The FGIS sample and inspection procedures as documented in their Grain Inspection Handbook therefore lack the second tier hygiene and treatment controls that underpin Australia's sample and inspection rates. Specific agreements on inspection standards would be needed.

6.2.3 Export Terminals

Grain is mainly transported by truck from farm/farm storage to elevator. Harvest and transport to storage is often performed by contractors who 'follow the season' from south to north. Transport from elevators to sub-terminals to export terminals in the Pacific North West and Texas Gulf is by rail. In addition, large quantities of grain are moved by barge down the Missouri/Mississippi River systems.

Export terminals are situated in the Pacific North West, Texas Gulf, Louisiana and California. They tend to operate on a 'just in time' principle with consolidated cargo moving from inland elevators just prior to the vessel arrival at the port. The terminals visited by the Grain Mission 1995 were flow through systems with little excess storage capacity.

The Grain Mission 1995 found that:

- Export Terminals have a capacity to blend grains and screenings similar to inland elevators and sub-terminals. This blending to achieve quality grades is normal practice in the USA grain market.
- Vessel loading is controlled by FGIS who release shipping bins for loading after grade standards have been checked.
- In consideration of post treatment security of maize consolidated for export to Australia the following factors require consideration:
    1. Management practices, particularly in usage of common elevators and flow paths, and segregation capacity of export terminals for storage of the treated lot.
    2. Hygiene/pest control practices, especially the potential for inadequate treatments to mask infestations of quarantine pests or encourage insecticide resistant strains of cosmopolitan (non-regulated) pests, and the capacity of these pests to cross infest/infect post treatment.
    3. Reject/treat/reinstate procedures for export grain, and capacity to inspect and if necessary divert grain from shipping bins.

Detailed procedures for storage, handling, hygiene and inspection/rejection of the treated maize and standards for pre loading verification of compliance will need to be supplied to the export terminal and to APHIS. In the absence of data, it is assumed that APHIS and/or FGIS do not have inspection/certification standards or accreditation training for acceptable procedures. An initial pre-clearance visit by an Australian inspector may be required to ensure correct interpretation of the procedures. In addition this visit could ensure that all stakeholders understand issues such as 'how clean is clean'. Subsequent shipments may be 'pre-cleared' on the basis of representative samples submitted for analysis prior to shipment, and a grain flowpath hygiene condition certificate endorsed by APHIS or an approved certifier supplied.

6.2.4 Ship inspection

The Grain Mission 1995 reported that FGIS has responsibility for carrying out stowage examinations on vessels in accordance with the provisions of the USA Grain Standards Act.

Stowage space is examined for:

- residues of previous cargoes
- rust scale and paint scale
- unsanitary conditions such as animal/rodent excreta or decaying matter

- unknown substances
- standing water in the hold
- objectionable foreign odours
- infestations with rodents or insects.

Holds that have been passed by FGIS as fit to load are listed on an Official Stowage Examination Certificate issued by FGIS. This certifies that the stowage areas were examined on a given date and found to be substantially clean, dry, free of insect infestation and suitable to carry grain or commodity.

Residues of previous cargoes in recent fertiliser vessels from the USA suggest that USA certification bodies, particularly private surveyors, either have a different interpretation as to what constitutes 'substantially clean, dry, free from insect infestation' or their ship survey procedures are inadequate. Schedule 4 of the Australian Export Control Act, Grain, Plants and Plant Products Orders, made under the Export Control Act (1982) and the Ship Inspection section of the Field Crops Manual provide extensive instruction on the required ship survey standards and procedures used in Australia.

A protocol for offshore treatment of maize needs to include ship survey standards and procedures equivalent to the Australian standard. A pre-clearance visit by an Australian inspector will be required to ensure that the certification body understands the interpretation and application of these standards.

7. OTHER ASSESSMENTS

Environmental Impact

The RAP is satisfied that the importation of maize from the USA under the specified conditions will present negligible risk to the environment and accordingly that the obligations arising from the Administrative Procedures made under the Environment Protection (Impact of Proposals) Act 1974 have been met.

8. COMPARISON WITH AUSTRALIA'S APPROPRIATE LEVEL OF PROTECTION

Australia has an obligation under the Sanitary and Phytosanitary Agreement to avoid arbitrary or unjustified distinctions in the levels of phytosanitary protection it considers appropriate in different situations if such distinctions result in discrimination or disguised restrictions on international trade. In broad terms this means that Australia must manage risk in a consistent manner. Therefore a comparison of the assessed risks of a specific proposal against other related quarantine decisions is an important part of the risk assessment.

The action taken by AQIS to protect Australia against significant cereal diseases is most relevant to consideration of maize. Wheat and other related cereals are generally prohibited entry to Australia, except under strict quarantine conditions including growth under quarantine for seed imports, because of concerns about a number of serious cereal diseases. In addition, AQIS imposes a nil tolerance for cereal contamination during inspection of some other products, such as fertiliser shipments. These are inspected and rejected or required to be cleaned or treated if cereal contamination is found. Although there are arrangements that allow the entry of some cereals for metropolitan processing under quarantine control, bulk shipments of cereals are not allowed unrestricted entry and release in Australia.

An analysis of alternative pathways for pest establishment can provide a useful measure of the risks faced from other pathways. For example, if there are other pathways for the entry of maize pests with substantially greater risks than the proposed trade then it may be difficult to justify restricting trade unless these other risks are addressed. The alternative pathways for the entry of maize pests include, entry with seed for planting, illegal entry of host material or accidental contamination of people or objects.

Importation of maize seed for sowing is subject to a series of strict quarantine conditions that reduce the risks of pest entry to a very low level. AQIS has extensive programs covering airports, ports and mail intended to intercept illegal entry of plant material and minimise the chances of pest entry via this pathway. There is a risk of accidental entry of maize pests but given the nature of the pests this risk is considered to be low.

At least 16 pathogens, 14 arthropods and 78 weed species, likely to be associated with bulk maize imports from the USA, are quarantine pests that could become established in Australia and cause significant economic damage. The maize would be transported to rural areas for processing and use as animal feed. There are significant risks of these pests finding a suitable environment for establishment and spread following spillage during transport, storage and processing, and, in some cases, after passage of the feed through the animal gut.

On the basis of a comparison of these phytosanitary risks with the action taken by AQIS on other imported commodities and the risks of entry via other pathways the RAP considers that the unrestricted import of bulk maize from the USA would not meet Australia’s appropriate level of protection.

9. RISK MANAGEMENT MEASURES

This section discusses the risk management measures that could be used to manage the quarantine risks associated with imports of bulk maize from the USA.

9.1 Area Freedom

Maize sourced from areas free of quarantine pests would be acceptable to AQIS, if appropriate phytosanitary measures are taken to prevent contamination during transport. Similarly, a sufficiently low incidence of a pest in areas from which the bulk maize is sourced could reduce the phytosanitary risk to a level acceptable to AQIS.

No maize producing State of the USA was free of all quarantine pests identified in this analysis. In addition to this, there are considerable practical difficulties in preserving the identity of maize sourced from such areas. Given the scope of the proposal, that maize is sourced from the USA as a whole, and difficulties with area preservation, localised area freedom or low incidence for all quarantine pests has not been addressed in detail in this IRA.

The RAP view is that area freedom is unlikely to be achievable for imports of bulk maize from the USA. However, area freedom remains an option if it can be shown that a region in the USA can demonstrate and maintain area freedom and the integrity of the grain can be satisfactorily maintained in transporting the grain from this area to Australia.

9.2 Treatment

The TWGs proposed various treatments. The RAP considered that any treatment, in which it was demonstrated to a high degree of certainty that maize was devitalised and pathogens and pests destroyed, could achieve Australia’s appropriate level of protection. On the basis of available information the RAP considered that the only likely candidate at this time is steam heat treatment. Irradiation and infrared heat treatment are examples of other treatments that should be capable of achieving the desired level of protection. However, given the lack of good efficacy data on these treatments more extensive development work may be required to demonstrate efficacy for these treatments compared to the work required for steam heat treatment.

Offshore treatment of bulk maize would be acceptable provided effective measures were taken to prevent post-treatment infection, infestation or contamination of the shipment.

10. DRAFT CONDITIONS FOR IMPORT

Given the disease, arthropod and weed quarantine risk identified, and the practical problems associated with control measures, the RAP recommends that bulk maize permitted to be imported from the USA to meet the proponent's request be subject to the conditions set out below.

The conditions are based on treatment in the USA and reflect the need for an integrated approach given the wide range of pests involved. However, it should be noted that these conditions represent the full range of measures that could be available. Specific conditions for individual shipments may vary depending on the configuration of sourcing, place of treatment and transport systems used.

1. *Sourcing*

   To minimise the chance of post-treatment contamination, infection or infestation, the commodity should be sourced from the northern USA States in the maize growing areas, where the incidence of several of the more significant maize diseases is lower than in the southern States and from where Karnal bunt has not been detected in surveys of wheat crops. The northern States also have the advantage of a lower incidence of arthropod pests of concern compared to the southern States, and the weed, *Striga asiatica*, is not present. Note: This requirement may be varied depending on the demonstrated treatment efficacy and the ability to maintain the integrity of the grain after treatment.

2. *Grade*

   The permitted maize grade standard should be US No. 2 Grade or better.

   Note: Given the earlier conclusion that grain would need to be rendered sterile and disinfected at the port of export in the USA, the likelihood of achieving this outcome is greater if a higher grade of corn is used, since a cleaner starting product provides more latitude in the application of the treatment. It is noted however that if the process used to treat the grain can be shown to be equally effective on other grades of corn then lower grades may be an acceptable alternative.

3. *Transportation*

   The selected maize should be transported, for subsequent shipment, to a port on the Pacific Northwest in a manner that preserves its identity.

   Note: Previous correspondence between AQIS and FGIS in 1995 resulted in an agreement by FGIS to provide identity preserved statements on export certificates stating that: "The grain loaded on board the MV (vessel name) was received from railcars loaded at (location and date) under the supervision of FGIS authorised/licensed personnel".

4. *Treatment*

   The maize should be treated in a facility at the export port to provide a high degree of confidence that all seeds present (ie maize, other crop seed admixture and weed seeds) are rendered non-viable and all plant pathogens and arthropod pests present in the grain are killed.

5. *Post-Treatment Conditioning*

   The treated maize should be conditioned immediately after treatment in a well cleaned plant to ensure that it is cooled to near ambient temperature and that its inherent moisture content is not more than 14% (wet basis).

Note: The requirement to condition grain to a moisture content of not more than 14% does not strictly speaking fall within the phytosanitary regulatory considerations, however it is essential to minimise heating of the grain, to prevent the development of mycotoxin producing fungi in the maize, and to reduce the risk of re-infestation or re-infection.

6. *Verification of treatment process*

Samples of the treated maize should be collected by either FGIS authorised/licensed personnel or APHIS personnel and forwarded by secure express air freight to AQIS for analysis to determine the efficacy of treatment. AQIS should also require documentary evidence of the treatment process such as records showing exposure period/temperature details for audit purposes.

Note: The tests for treatment efficacy could be carried out in the USA under FGIS or APHIS supervision subject to agreement with AQIS on conditions for carrying out and reporting these tests.

7. *Storage prior to shipment*

The treated and conditioned maize stocks should be stored in a well cleaned, segregated facility to prevent any contact with untreated grain stocks or confusion as to the special status of the treated maize.

8. *Loading path to export vessel*

The grain loading path from the storage location to the ship must be thoroughly clean and free from residues from previous grain handling operations.

9. *Phytosanitary certification*

AQIS will require a phytosanitary certificate issued by APHIS including the treatment details for the maize and certifying that no infestation was detected in representative samples inspected during loading of the vessel.

10. *Ship hygiene*

The ship to be loaded should be preinspected and certified to be substantially free from previous cargo residues and live insects by FGIS grain inspection staff.

Note: Standard stowage examination procedures are used by FGIS to certify all stowage space examined and result in the issuance of a certificate stating that: "Stowage space examined on the above date and found to be substantially clean, dry, free of insect infestation, and suitable to store or carry grain." Experience from inspection of bulk carriers arriving in Australia and from the USA Grain Mission in 1995 has clearly shown that the interpretation of 'substantially clean' by FGIS is not as rigorously enforced as the Australian standards. This will require further clarification by AQIS to the USA authorities to ensure that ship inspection meets the AQIS export standard. Alternatively, this may be achieved by preclearance procedures using selected AQIS staff.

11. *On-arrival inspection*

On arrival of the ship in Australia, the treated maize cargo should be inspected by AQIS prior to and during discharge of the cargo. The inspection is to provide a high degree of confidence that the condition of the cargo is consistent with the analysis conducted on preshipment samples and that the treated maize has not been infested or in any other way contaminated in post-treatment storage or from the ship. Following successful AQIS inspection and any other testing or analysis deemed necessary, the cargo may be released from quarantine for unrestricted movement.

11. COMMENTS RAISED BY STAKEHOLDERS IN RESPONSE TO THE *ISSUES PAPER*

	STAKEHOLDER COMMENT	RESPONSE
1.	The *Issues Paper* does not appear to make a distinction between the different varieties of *Zea mays L.* of the areas of production.	The RAP considered that variety integrity could not be ensured for low cost bulk maize
2.	Growing areas, varieties and length of the growing period also have a significant affect on disease presence in the USA. These aspects should therefore be considered by the TWGs.	The RAP has considered these issues. Some information has been obtained through literature searches. Confirmation of information has been sought from APHIS on some aspects.
3.	Consideration should be given to treatments that are used in the normal production and distribution of maize in the USA that will have an effect in the reduction of quarantine risk. These include, but are not limited to, drying and screening.	These issues have been considered by the RAP and are discussed within this document.
4.	Have the Grains Taskforce USA visit recommendations relating to disease transmission and incidence, identity preservation arrangements and operational issues relating to barge transport been addressed?	Barge transport is not relevant given the recommendation to source from the Pacific northwest. Other issues have been addressed within this document, however it is important to note that this analysis has considered in more detail the phytosanitary risks associated with USA maize.
5.	Will new quarantinable pests and diseases further to those identified in previous risk analyses be identified throughout the process?	New quarantine pests and diseases have been identified and are discussed within this document.
6.	Has the Pathogen TWG taken account of high resistance of field corn to Goss's bacterial wilt?	This issue has been considered in detail and is discussed in the Pathogen TWG report available from the public file.
7.	The following pests, diseases and weeds are cited in the *Issues Paper* as quarantine concerns, however, some references suggest that these are already present in Australia? . head smut . boil smut . maize dwarf mosaic virus . high plain disorder . warehouse beetle . *Ambrosia artemisiifolia* . *Cenchrus pauciflorus* . *Cirsium arvense* . *Convulvulus arvensis* . *Datura* spp. . *Setaria faberi* . *Sorghum halepense* . *Striga asiatica* . *Xanthium* spp.	These issues have been dealt with in the relevant TWG reports.

	STAKEHOLDER COMMENT	RESPONSE
8.	The Arthropod Pest TWG should consider the presence or absence in Australia of the mite vectors that are involved in the transmission of the viral diseases including high plains disorder.	This issue has been considered by the Arthropod Pest TWG and has been discussed in their report.
9.	The Operational TWG should look at options for reducing contamination.	This was essentially by a combination of higher grades (US No.2 or better) and treatment
10.	The qualifications of the Weed TWG consultant were not specified.	Dr John Swarbrick taught and carried out research in weed science for 30 years in the UK and Australia. He retired as Associate Professor of Weed Science at the University of Queensland in 1994 and has since been active as a weed science consultant for AQIS, the Queensland Department of Environment, Local Government bodies and engineering companies. Dr Swarbrick is author or co-author of 13 books and monographs, 6 book chapters, 3 databases and 24 refereed journal articles on weeds and weed control.
11.	The *Issues Paper* contained only seed pests.	All pests associated with maize in the USA were evaluated for quarantine status and presence in the specified pathway.
12.	Five weeds listed in the *Issues Paper* are of particular concern, namely: . *Ambrosia* spp. . *Cirsium arvensis* . *Convolvulus arvensis* . *Kochia scopari* . *Xanthium strumarium*	All of these species are classified as quarantine pests and will be managed accordingly.

12. REFERENCES

Anon (1994). Report on weed risk assessment on United States and Canada grain for the Grains Task Force. Rivers and Associates.Anon (1994)

Anon (1998) *The AQIS Import Risk Analysis Process Handbook*. AQIS

Banks, H.J. (in press) Prospects for heat disinfestation. *Proceedings of the Australian Postharvest Technical Conference*, Canberra, May 1998.

Banks, H.J. & Fields, P. (1995) Physical methods for insect control in stored-grain ecosystems, pp. 353-409 In: Jayas, D.S., White, N.D.G., Muir, W.E. (1995) *Stored-Grain Ecosystems*. Marcel Dekker: New York

Bigeriwa, G., Adipala, E., and Esele J. P. 1998. Occurrence of *Peronosclerospora sorghi* in Uganda. Plant Disease **82**: 757–760.

Bond, E., J. (1984) Manual of fumigation for insect control. *FAO Plant Production and Protection Paper No. 54.* FAO: Rome

Carringer RD, Fawcett RS and Bryant WE (1980) Perennial broadleaf weed control with pre-harvest applications of glyphosate. In *Proceedings North Central Weed Control Conference*. Vol **34**, 56.

Christian, M.L., and Willis, W.G. 1993. Survival of wheat streak mosaic virus in grass hosts in Kansas from wheat harvest to fall wheat emergence. Plant Disease 77: 239–242.

Coe *et al.* 1988

Evans G, Clark A, Love J. Cannon R and McLean G. (1996) Quarantine risk associated with the importation of bulk grain: a retrospective analysis. Bureau of Resource Sciences. Canberra. DPIE.

Fields, P. G. (1992) The control of stored-product insects and mites with extreme temperatures. *Journal of Stored Product Research* **28**: 89-118

Frederiksen, R. A. 1980. Sorghum downy mildew in the United States: overview and outlook. Plant Disease **64**: 903–908.

Gould FW (1968). Grass systematics. McGraw Hill, New York.

Grain Taskforce file (1995). AQIS

Henderson RJ (1984.) Personal communication 16/3/1984. Supervising Botanist, Queensland Herbarium, Indooroopilly, Brisbane.

Hill, J.H., Martinson, C.A., and Russell, W.A. 1974. Seed transmission of maize dwarf mosaic and wheat streak mosaic viruses in maize and response of inbred lines. Crop Science **14**: 232–235.

Hnatiuk, RJ (1990). Census of Australian vascular plants. Australian flora and fauna series Number 11. An AGPS press publication. Australian Government Publishing Service, Canberra.

Jeger, M.J., Gilijamse, E., Bock, C.H. and Frinking, H.D. 1998. The epidemiology, variability and control of the downy mildews of pearl millet and sorghum, with particular reference to Africa. Plant Pathology **47**: 544–569.

Keyes, L., Rosenow, D. T., Berry, R. W., and Futrell, M. C. 1964. Downy mildew and head smut diseases of sorghum in Texas. Plant Disease Reporter **48**: 249–253.

Marcon, A., Kaeppler, S.M. and Jensen, S.G. 1997. Genetic variability among maize inbred lines for resistance to the High Plains virus - wheat streak mosaic virus complex. Plant Disease **81**: 195–198.

McKinney, H.H. 1937. Mosaic disease of wheat and related cereals. U.S. Dept. Agric. Circ. 442

McNeil, J.E., French, R., Hein, G.L., Baenziger, P.S., and Eskridge, K.M. 1996. Characterization of genetic variability among natural populations of wheat streak mosaic virus. Phytopathology **86**: 1222–1227.

National Working Party on Grain Protection 1997

Pataky, J. K., and Pataky, N R. 1990. Sorghum downy mildew on sweet corn in Central Illinois. Plant Disease **74**: 183.

Phillips D. (1994). Pest risk analysis of seed-borne pests of barley, maize and sorghum from the USA, and barley from Canada. Part 1. Bureau of Resource Sciences.Phillips (1994a)

Phillips D., Roberts W., and Chandrashekar M. (1994). Pest risk analysis of seed-borne pest of barley, wheat, maize and sorghum from the USA and Canada. Part 2. Bureau of Resource Science. Canberra. DPIE.

Ramsey M. D. and Jones D. R. (1988). *Peronosclerospora maydis* found on maize, sweetcorn and plume sorghum in Far North Queensland Plant Pathology **37**, 581-587.

Rees, D.P. & Banks, H.J. (1998) The khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae), a quarantine pest of stored products: Review of biology, distribution, monitoring and control. A report written for AQIS, Canberra, Australia.

Roberts W., Magee W., Dodman R., Price J., McCallum A., Heinrich D. and Hartwell J. (1995). Report of grain mission on sourcing sorghum from USA. Australian Quarantine and Inspection Service, Canberra.Roberts *et al.* (1995)

Sand P.F. (1979). Witchweed - will it invade the Midwest? *Weeds Today, Winter*: 5-6.

Shivas, R. G. (1989). *Fungal and bacterial diseases of plants in Western Australia. J. Roy. Soc. W. Aust.* **72**, 1-62.

Smiley, R. L. (1991) Mites (Acari) in: Gorham, J. R. Ed (1991) *Insects and Mite Pests in Food, an Illustrated Key*. USDA Agriculture handbook No. 655, Washington DC, USA, Vol. 1, 3 - 44.

Tweedie W. R. (1970). Downy mildew of sweet corn in Western Australia. *Australian Plant Disease Recorder* **22**, 33.

Vangessel M.J., Johnson Q. and Isaacs M. (1996) Response of sethoxydim- resistant corn *(Zea mays L.*) hybrids to postemergence graminicides. *Weed Technology***. 11**, 598-601.

Young B.G. and Hart S.E. (1997). Control of volunteer sethoxydim resistant corn (*Zea mays L.*) in soybean (*Glycine max*). *Weed Technology*. **11**, 649-655.

13. APPENDIX 1

PREVIOUS REVIEWS ON THE IMPORT OF MAIZE GRAIN FROM THE USA

Phillips, D. (1994). Pest risk analysis of seed-borne pests of barley, maize and sorghum from the USA, and barley from Canada. Part 1. Bureau of Resource Sciences.

Phillips, D., Roberts, W., and Chandrashekar, M. (1994). Pest risk analysis of seed-borne pests of barley, wheat, maize and sorghum from the USA and Canada. Part 2. Bureau of Resource Sciences

Anon. (1994). Report on weed risk assessment on United States and Canada grain for the Grains Task Force. Rivers and Associates.

Roberts, W., Magee, W., Dodman, R., Price, J., McCallum, A., Heinrich, D. and Hartwell, J. (1995). Report of grain mission on sourcing sorghum from USA. Australian Quarantine and Inspection Service, Canberra.

Roberts, W., Magee, W., Dodman, R., Price, J., McCallum, A., Heinrich, D. and Hartwell, J. (1995). Supplementary report of grain mission USA. Australian Quarantine and Inspection Service, Canberra.

Evans, G., Clark, A., Love, J., Cannon, R. and McLean, G. (1996). Quarantine risk associated with the importation of bulk grain - A retrospective analysis. Bureau of Resource Sciences.

OTHER RELEVANT REFERENCES

Anon. (1997). Australian Quarantine: A shared responsibility. The Government response. Commonwealth of Australia, Canberra.

FAO (1995). Principles of plant quarantine as related to international trade. ISPM Pub. No. 1, FAO, Rome.

FAO (1996). Import regulations. Guidelines for pest risk analysis. ISPM Pub. No. 2, FAO, Rome.

FAO (1997a). Glossary of phytosanitary terms. ISPM Pub. No. 5, FAO, Rome.

FAO (1997b). International Plant Protection Convention. (Revised text). FAO, Rome.

GATT (1994). Agreement on the Application of Sanitary and Phytosanitary Measures. p. 69-83. In: Final Act Embodying the results of the Uruguay Round. Multilateral Trade Negotiations, The Uruguay Round, GATT Secretariat, UR-94-0083. Marrakesh, GATT.

Nairn, M.E., Allen, P.G., Inglis, A.R. & Tanner, C. (1996). Australian Quarantine: A shared responsibility. Department of Primary Industries and Energy, Canberra.

14. APPENDIX 2: Quarantine status of pests, pathogens and weeds associated with bulk grain imports from the USA

Table 14.1.Quarantine status of pathogens associated with bulk grain imports from the USA

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
BACTERIA								
Acidovorax avenae subsp. ***avenae*** (Manns) Willems *et al*. 1992	bacterial leaf blight	Yes	Yes	races?	Yes	Yes		?
Bacillus subtilis (Ehrenberg) Cohn	kernel rot; blight	Yes	Yes	Non-quarantine				
Burkholderia andropogonis (Smith) Gillis *et al*. 1995	bacterial stripe	Yes	Yes	Non-quarantine				
Clavibacter michiganensis subsp. ***nebraskensis*** (Vidaver & Mandel) Davis *et al*. 1984	Goss's bacterial wilt and blight	Yes	No	Quarantine	yes	yes	High	yes
Erwinia carotovora subsp. ***carotovora*** (Jones) Bergey *et al*.1923	bacterial stalk and top rot	Yes	Yes	Non-quarantine				
Erwinia chrysanthemi pv. ***zeae*** (Sabet) Victoria *et al*. 1975	bacterial stalk and top rot	Yes	Yes	Non-quarantine				
Erwinia dissolvens (Rosen) Burkholder 1948	bacterial stalk rot	Yes	No	Quarantine	yes	No		
Erwinia herbicola (Lohnis) Dye 1964	halo blight of corn	Yes	Yes	Non-quarantine				
Pantoea stewartii subsp. ***stewartii*** (Smith) Mergaert *et al*. 1993	Stewart's bacterial wilt	Yes	No	Quarantine	yes	yes	High	yes
Pseudomonas syringae pv. ***lapsa*** (Ark) Young *et al*. 1978	bacterial stalk rot	Yes	No	Quarantine	yes	No		
Pseudomonas syringae pv. ***syringae*** van Hall 1902	holcus bacterial spot	Yes	Yes	Non-quarantine				
Pseudomonas syringae pv. ***coronafaciens*** (Elliott) Young *et al*. 1978	chocolate spot	Yes	Yes	Non-quarantine				
Xanthomonas vasicola pv. ***holcicola*** (Elliott) Vauterin *et al*. 1995	bacterial leaf spot	Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
FUNGI								
Absidia corymbifera (Cohan) Sacc. & Trott.		Yes	No	Quarantine	Yes	no		
Absidia repens Tiegh		Yes	No	Quarantine	Yes	no		
Acremonium strictum Gams	black bundle	Yes	Yes	Non-quarantine				
Acremonium zeae Gams & Sumner	Acremonium stalk rot	Yes	Yes	Non-quarantine				
Acrodictys erecta (Ellis & Everh.) Ellis		Yes	No	Quarantine	Yes	no		
Actinomucor elegans (Eidam) Benjamin & Hesseltine		Yes	Yes	Non-quarantine				
Alternaria alternata (Fr.:Fr.) Keissl.	Alternaria leaf blight	Yes	Yes	Non-quarantine				
Alternaria longissima Deighton & MacGarvie	stalk rot	Yes	Yes	Non-quarantine				
Ascochyta ischaemi Sacc.	yellow leaf blight	Yes	No	Quarantine	Yes	no		
Ascochyta maydis Stout.	Ascochyta leaf blight	Yes	No	Quarantine	Yes	no		
Ascochyta tritici Hori & Enjoji		Yes	No	Quarantine	Yes	no		
Ascochyta zeicola Ellis & Everh.	Ascochyta leaf spot	Yes	Yes	Non-quarantine				
Aspergillus alliaceus Thom & Church		Yes	Yes	Non-quarantine				
Aspergillus caespitosus Raper & Thom		Yes	No	Quarantine	yes	no		
Aspergillus candidus Link		Yes	Yes	Non-quarantine				
Aspergillus carbonarius (Bainier) Thom		Yes	Yes	Non-quarantine				
Aspergillus chevalieri (Mangin) Thom & Church var. ***intermedius***		Yes	No	Quarantine	Unknown			?
Aspergillus clavatus Desmaz.		Yes	Yes	Non-quarantine				
Aspergillus echinulatus (Delacr.) Thom & Church		Yes	No	Quarantine	Unknown			?
Aspergillus elegans Gasp.		Yes	No	Quarantine	Unknown			?

AQIS Protecting your way of life!

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Aspergillus equitis Samson & Gams		Yes	Yes	Non-quarantine				
Aspergillus flavipes (Bainier & Sartory) Thom & Church		Yes	Yes	Non-quarantine				
Aspergillus flavus Likn:Fr.		Yes	Yes	Non-quarantine				
Aspergillus fumigatus Fresen.		Yes	Yes	Non-quarantine				
Aspergillus glaucus Link:Fr.	Aspergillus ear rot; yellow mould	Yes	Yes	Non-quarantine				
Aspergillus hollandicus Samson & Gams		Yes	Yes	Non-quarantine				
Aspergillus mangini Thom & Raper		Yes	No	Quarantine	Unknown			?
Aspergillus nidulellus Samson & Gams		Yes	Yes	Non-quarantine				
Aspergillus niger Tiegh.	Aspergillus ear rot; black mould	Yes	Yes	Non-quarantine				
Aspergillus ochraceus Wilh.		Yes	Yes	Non-quarantine				
Aspergillus parasiticus Speare		Yes	Yes	Non-quarantine				
Aspergillus reptans Samson & Gams		Yes	Yes	Non-quarantine				
Aspergillus restrictus Sm.		Yes	Yes	Non-quarantine				
Aspergillus rubrobrunneus Samson & Gams		Yes	No	Quarantine	Unknown			?
Aspergillus stellifer Samson & Gams		Yes	No	Quarantine	Unknown			?
Aspergillus sulphureus (Fresen.) Wehmer		Yes	No	Quarantine	Unknown			?
Aspergillus sydowii (Bainier & Startory) Thom & Church		Yes	Yes	Non-quarantine				
Aspergillus tamarii Kita		Yes	No	Quarantine	Unknown			?
Aspergillus unguis (EmilenoWeil & Gaudin) Thom & Raper		Yes	No	Quarantine	Unknown			?
Aspergillus ustus (Bainier) Thom & Raper		Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Aspergillus versicolor (Vuill.) Tiraboschi		Yes	Yes	Non-quarantine				
Aspergillus wentii Wehmer		Yes	Yes	Non-quarantine				
Aureobasidium pullulans (de Bary) Arnaud	brown spot	Yes	Yes	Non-quarantine				
Aureobasidium zeae (Narita & Hiratsuka) Dingley	eye spot; brown spot	Yes	No	Quarantine	Unknown			?
Basidiobotrys pallida (Berk. & Curtis) Hughes		Yes	No	Quarantine	Unknown			?
Bipolaris australiensis (Ellis) Tsuda & Ueyama	leaf spot	Yes	Yes	Non-quarantine				
Bipolaris cynodontis (Marig.) Shoemaker	leaf spot	Yes	Yes	Non-quarantine				
Bipolaris hawaiiensis (Ellis) Uchida & Aragaki	Helminthosporium leaf spot	Yes	Yes	Non-quarantine				
Bipolaris maydis (Nisikadad Miyaka) Shoemaker	southern leaf blight	Yes	Yes	Races?	Yes	Yes		?
Bipolaris sacchari (Butler) Shoemaker		Yes	Yes	Non-quarantine				
Bipolaris setariae (Sawada) Shoemaker	spot blotch	Yes	Yes	Non-quarantine				
Bipolaris sorghicola (Lefebvre & Sherwin) Alcorn		Yes	Yes	Non-quarantine				
Bipolaris sorokiniana (Sacc.) Shoemaker	Helminthosporium root rot	Yes	Yes	Non-quarantine				
Bipolaris urochloae (Putterill) Shoemaker	leaf spot	Yes	Yes	Non-quarantine				
Bipolaris victoriae (Meehan & Murphy) Shoemaker		Yes	Yes	Non-quarantine				
Bipolaris zeicola (Stout) Shoemaker	northern leaf blight	Yes	Yes	Races?	Yes	Yes		?
Blakeslea trispora Thaxt.		Yes	Yes	Non-quarantine				
Botryosphaeria disrupta (Berk. & Curtis) Arx & Mueller	ear rot	Yes	No	Quarantine	Unknown			?
Botryosphaeria festucae (Lib.) Arx & Mueller	ear rot	Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Botryosphaeria quercuum (Schwein.) Sacc.	ear rot	Yes	Yes	Non-quarantine				
Botryosphaeria rhodina (Cooke) Arx	ear rot	Yes	No	Quarantine	Unknown			?
Botryosphaeria zeae (Stout) Arx & Mueller	gray ear rot	Yes	No	Quarantine	Unknown	No		
Botrytis cineria Pers.: Fr.	Botrytis stalk rot	Yes	Yes	Non-quarantine				
Byssochlamys nivea Westling		Yes	No	Quarantine	Unknown			?
Candida albicans (Robin) Berkhout		Yes	No	Quarantine	Unknown			?
Candida guilliermondii (Castellani) Langeron & Guerra		Yes	No	Quarantine	Unknown			?
Candida intermedia (Cif. & Ashford) Langeron & Guerra		Yes	No	Quarantine	Unknown			?
Candida krusei (Castellani) Berkhout		Yes	Yes	Non-quarantine				
Candida parapsilosis (Ashford) Langeron & Talice		Yes	No	Quarantine	Unknown			?
Candida pseudotropicalis (Castellani) Basgal		Yes	No	Quarantine	Unknown			?
Ceratocystis paradoxa (Dade) Moreau	leaf spot	Yes	Yes	Non-quarantine				
Cercospora sorghi Ellis & Evrh.	gray leaf spot	Yes	Yes	Non-quarantine				
Cercospora zeae-maydis Tehon & Daniels	gray leaf spot	Yes	No	Quarantine	yes	yes	Medium	yes
Chaetomium bostrychodes Zopf		Yes	No	Quarantine	Unknown			?
Chaetomium brasiliense Batista & Pontual		Yes	No	Quarantine	Unknown			?
Chaetomium dolichptrichum Ames		Yes	No	Quarantine	Unknown			?
Chaetomium funicola Cooke		Yes	Yes	Non-quarantine				
Chaetomium globosum Kunze:Fr.		Yes	Yes	Non-quarantine				
Chaetomium indicum Corda		Yes	Yes	Non-quarantine				
Chaetomium murorum Corda		Yes	No	Quarantine	Unknown			?
Chaetomium torulosum Bainier		Yes	No	Quarantine	Unknown			?

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Chrysonilia sitophilia (Mont.) Arx		Yes	Yes	Non-quarantine				
Ciccinella muscae (Sorokin) Berl. & DE Toni		Yes	No	Quarantine	Unknown			?
Cladosporium cladosporioides (Fresen.) De Vries	Cladosporium rot	Yes	Yes	Non-quarantine				
Cladosporium herbarum (Pers.:Fr.) Link	cob mould	Yes	Yes	Non-quarantine				
Cladosporium macrocarpum Preuss	cob mould	Yes	Yes	Non-quarantine				
Cladosporium tenuissimum Cooke		Yes	Yes	Non-quarantine				
Cladosporium zeae Peck		Yes	No	Quarantine	Unknown			?
Colletotrichum cereale Manns in Selby & Manns		Yes	No	Quarantine	Unknown			?
Colletotrichum graminicola (Ces.) Wils.	anthracnose	Yes	Yes	Races?	Yes	Yes		?
Coniothyrium scirpi Trail	leaf spot	Yes	Yes	Non-quarantine				
Corynascus sepedonium (Emmons) Arx		Yes	Yes	Non-quarantine				
Cryptococcus laurentii (Kuff.) Skinner		Yes	No	Quarantine	Unknown			?
Curvularia brachyspora Boedijn	leaf spot	Yes	Yes	Non-quarantine				
Curvularia clavata P.C.Jain	leaf spot	Yes	Yes	Non-quarantine				
Curvularia eragrostidis (Henn.) Meyer	Curvularia leaf spot	Yes	Yes	Non-quarantine				
Curvularia geniculata (Tracy & Earle) Boedijn	Curvularia leaf spot	Yes	Yes	Non-quarantine				
Curvularia gudauskasii (Morgan-Jones & Karr)	leaf spot	Yes	Yes	Non-quarantine				
Curvularia inaequalis (Shear) Boedijn	Curvularia leaf spot	Yes	Yes	Non-quarantine				
Curvularia intermedia Boedijn	Curvularia leaf spot	Yes	Yes	Non-quarantine				
Curvularia lunata (Wakk.) Boedijn	Curvularia leaf spot	Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Curvularia pallescens Boedijn	Curvularia leaf spot; leaf spot of maize; corn leaf spot	Yes	Yes	Non-quarantine				
Curvularia senegalensis (Speg.) Subramanian	Curvularia leaf spot	Yes	Yes	Non-quarantine				
Curvularia tuberculata P.C.Jain	leaf spot	Yes	Yes	Non-quarantine				
Dendrophoma zeae Tehon		Yes	Yes	Non-quarantine				
Diaporthe phaseolorum (Cooke & Ellis) Sacc.	seedling blight	Yes	Yes	Non-quarantine				
Dictyochaeta fertilis (Hughes & Kendrick) Holubova-Jechova	root rot	Yes	Yes	Non-quarantine				
Dictyochora gambellii Fairm.		Yes	No	Quarantine	Unknown			?
Didymella exitialis (Morini) Mueller	Didymella leaf spot	Yes	Yes	Non-quarantine				
Didymium iridis (Ditmar) Fr.		Yes	No	Quarantine	Unknown			?
Didymosphaeria graminicola Ellis & Everh.		Yes	No	Quarantine	Unknown			?
Diplodia maydis (Berk.) Sacc.	Diplodia ear and stalk rot	Yes	Yes	Non-quarantine				
Doratomyces stemonitis (Per.:Fr.) Morton & Sm.	ear rot	Yes	Yes	Non-quarantine				
Epicoccum nigrum Link	red kernel; red kernel disease	Yes	Yes	Non-quarantine				
Exserohilum monoceras (Drechs.) Leonard & Suggs	leaf blotch	Yes	Yes	Non-quarantine				
Exserohilum pedicellatum (Henry) Leonard & Suggs	Helminthosporium root rot	Yes	Yes	Non-quarantine				
Exserohilum prolatum Leonard & Suggs	Exserohilum leaf spot	Yes	Yes	Non-quarantine				
Exserohilum rostratum (Drechs.) Leonard & Suggs	Helminthosporium leaf disease	Yes	Yes	Non-quarantine				
Exserohilum turcicum (Pass.) Leonard & Suggs	northern leaf blight	Yes	Yes	Races?	Yes	Medium	Yes	?
Fusarium acuminatum Ellis & Everh.	root and stem rot	Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Fusarium avenaceum (Fr.: Fr.) Sacc.	stalk and root rot	Yes	Yes	Non-quarantine				
Fusarium chlamydosporum Wollenweb. & Reinking		Yes	Yes	Non-quarantine				
Fusarium crookwellense Burgess *et al.*	stem rot	Yes	Yes	Non-quarantine				
Fusarium culmorum (Wm. G. Sm.) Sacc.	stalk rot	Yes	Yes	Non-quarantine				
Fusarium episphaeria (Tode) Snyder & Hans.	stalk rot	Yes	Yes	Non-quarantine				
Fusarium equiseti (Corda) Sacc.	stalk rot	Yes	Yes	Non-quarantine				
Fusarium graminearum Schwabe	Gibberella stalk rot; red ear rot; pink ear rot	Yes	Yes	Non-quarantine				
Fusarium merismoides Corda	stalk rot	Yes	Yes	Non-quarantine				
Fusarium moniliforme Sheld.	Fusarium ear and stalk rot; Fusarium kernel rot	Yes	Yes	Non-quarantine				
Fusarium oxysporum Schlechtend.:Fr.	root rot	Yes	Yes	Non-quarantine				
Fusarium pallidoroseum (Cooke) Sacc.	root rot	Yes	Yes	Non-quarantine				
Fusarium poae (Peck) Wollenweb.	white cob rot; silver top	Yes	Yes	Non-quarantine				
Fusarium proliferatum (Matsushima) Nirenberg	root rot	Yes	Yes	Non-quarantine				
Fusarium roseum Link: Fr.	root rot	Yes	Yes	Non-quarantine				
Fusarium sacchari (Butler) Gams		Yes	No	Quarantine	Yes	no		
Fusarium solani (Mart.) Sacc.	stalk rot	Yes	Yes	Non-quarantine				
Fusarium subglutinans (Wollenweb. & Reinking) Nelson *et al.*	Fusarium stalk and ear rot	Yes	Yes	Non-quarantine				
Fusarium tricinctum (Corda) Sacc	root rot	Yes	Yes	Non-quarantine				
Fusisporium cerealis Cooke		Yes	No	Quarantine	Unknown	No		

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Gaeumannomyces graminis (Sacc.) Arx & Olivier	root rot	Yes	Yes	Non-quarantine				
Geotrichum candidum Link	stalk rot	Yes	Yes	Non-quarantine				
Gibberella cyanogena (Desmaz.) Sacc.	root rot	Yes	Yes	Non-quarantine				
Gibberella pulicaris (Fr.:Fr.) Sacc.	root rot	Yes	Yes	Non-quarantine				
Glabrocyphella ellisiana Cooke		Yes	No	Quarantine	Unknown			?
Gloeocercospora sorghi Bain & Edgerton ex Deighton	zonate leaf spot	Yes	No	Quarantine	Unknown			?
Glomerella tucumanensis (Speg.) Arx & Mueller		Yes	Yes	Non-quarantine				
Gonatobotrys simplex Corda	Gonatobotrys seed rot	Yes	Yes	Non-quarantine				
Gonatobotrys zeae Futrell & Bain	Gonatobotrys seed rot	Yes	No	Quarantine	Yes	no		
Graphium penicillioides Corda	leaf spot	Yes	No	Quarantine	Yes	no		
Hansenula anomala (Hans.) Syd. & Syd.		Yes	No	Quarantine	Yes	no		
Harzia acremonioides (Harz) Costantin		Yes	Yes	Non-quarantine				
Helminthosporium ahmadii Ellis		Yes	No	Quarantine	Yes	no		
Illosporium pallidum Cooke		Yes	No	Quarantine	Unknown	No		
Isariopsis subulata Ellis & Everh.		Yes	No	Quarantine	Unknown	No		
Lasiodiplodia theobromae (Pat) Griffon & Maubl.	black kernel rot	Yes	Yes	Non-quarantine				
Lecanidion atratum (Hedw.) Rabenh.		Yes	Yes	Non-quarantine				
Leptosphaeria macrospora (Fuckel) Thuem.	leaf spot	Yes	No	Quarantine	Yes	no		
Leptosphaeria maydis Stout	leaf spot	Yes	No	Quarantine	Unknown	No		
Leptosphaeria variisepta Stout	Leptosphaeria leaf spot	Yes	No	Quarantine	Yes	no		
Leptosphaerulina trifolii (Rostr.) Petr.		Yes	Yes	Non-quarantine				
Leptothyrium zeae Stout	leaf spot	Yes	No	Quarantine	Yes	no		
Ligniera junci (Schwartz) Maire & Tison		Yes	No	Quarantine	Yes	no		
Lophiosphaera zeicola Ellis & Everh.		Yes	No	Quarantine	Unknown			?

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Lophiostoma arundinis (Pers.:Fr.) Ces. & De Not)		Yes	No	Quarantine	Unknown			?
Macrophomina phaseolina (Tassi) Goidanich	charcoal rot	Yes	Yes	Non-quarantine				
Macrosporium maculatum Cooke & Ellis in Sumstein, nom. nud.		Yes	No	Quarantine	Yes	no		
Marasmius graminum (Lib.) Berk.	seedling and foor rot	Yes	Yes	Non-quarantine				
Marasmius sacchari Wakk.	Marasmius root and stalk rot	Yes	Yes	Non-quarantine				
Mariannaea elegans (Corda) Samson	stalk rot	Yes	Yes	Non-quarantine				
Massarina arundinacea (Sowerby:Fr.) Leuchtmann		Yes	No	Quarantine	Yes	no		
Melanospora zamiae Corda		Yes	No	Quarantine	Unknown			?
Microascus cinereus (EmilenoWeil & Gaudin) Curzi		Yes	No	Quarantine	Yes	no		
Microascus cirrosus Curzi		Yes	No	Quarantine	Yes	no		
Microascus desmosporus (Lechmere) Curzi		Yes	No	Quarantine	Unknown			?
Microascus longirostris Zukal		Yes	No	Quarantine	Yes	no		
Microdochium bolleyi (Sprague) De Hoog & Hermanides-Nijhof	Microdochium root rot	Yes	Yes	Non-quarantine				
Microdochium nivale (Fr.) Samuels & Hallett	Microdochium root rot	Yes	Yes	Non-quarantine				
Monascus purpureus Went	silage mold	Yes	No	Quarantine	Unknown			?
Monascus ruber Diegh.	silage mold	Yes	No	Quarantine	Unknown			?
Mucor circinelloides Teigh.		Yes	Yes	Non-quarantine				
Mucor fragilis Bainier	seedling rot	Yes	Yes	Non-quarantine				
Mucor heimalis Wehmer		Yes	No	Quarantine	Yes	no		
Mucor mucedo Mich. Ex Saint-Amans		Yes	No	Quarantine	Yes	no		
Mucor plumbeus Bonord.		Yes	Yes	Non-quarantine				
Mucor racemosus Fresen.		Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Mycosphaerella zeae (Sacc.) Woronow	leaf blight	Yes	No	Quarantine	Yes	no		
Myrothecium cinctum (Corda) Sacc.	root rot	Yes	Yes	Non-quarantine				
Myrothecium gramineum Lib.	shuck rot	Yes	No	Quarantine	Yes	no		
Myrothecium verrucaria (Albertini & Schwein.) Ditmar.:Fr.	root rot	Yes	Yes	Non-quarantine				
Nigrospora oryzae (Berk. & Broome) Petch	Nigrospora ear rot	Yes	Yes	Non-quarantine				
Nigrospora sphaerica (Sacc.) Mason	stalk rot	Yes	Yes	Non-quarantine				
Olpitrichum macrosporum (Farl.) Sumstine		Yes	Yes	Non-quarantine				
Olpitrichum tenellum (Berk. & Curtis) Holubova-Jechova		Yes	No	Quarantine	Unknown			?
Ophiliosphaerella herpotricha (Fr.:Fr.) Walker		Yes	No	Quarantine	Unknown			?
Paraphaeosphaeria michotii (Westend.) Eriksson	leaf spot	Yes	Yes	Non-quarantine				
Penicillium aurantiogriseum Dierckx		Yes	Yes	Non-quarantine				
Penicillium brevicompactum Dierckx		Yes	Yes	Non-quarantine				
Penicillium canescens Sopp		Yes	Yes	Non-quarantine				
Penicillium chrysogenum Thom		Yes	Yes	Non-quarantine				
Penicillium citrinum Thom		Yes	Yes	Non-quarantine				
Penicillium clarviforne Bainier		Yes	No	Quarantine	Unknown			?
Penicillium crustosum Thom		Yes	Yes	Non-quarantine				
Penicillium expansum Link	Penicillium ear rot	Yes	Yes	Non-quarantine	Unknown			?
Penicillium felludanum Biourge		Yes	No	Quarantine	Unknown			?
Penicillium funiculosum Thom		Yes	Yes	Non-quarantine				
Penicillium glabrum (Wehmer) Westling		Yes	No	Quarantine	Unknown			?

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Penicillium granulatum Bainier		Yes	No	Quarantine	Unknown			?
Penicillium grisefulvum Dierckx		Yes	No	Quarantine	Unknown			?
Penicillium herquei Bainier & Sartory		Yes	No	Quarantine	Unknown			?
Penicillium implicatum Biourge		Yes	No	Quarantine	Unknown			?
Penicillium janthinellum Biourge		Yes	No	Quarantine	Unknown			?
Penicillium oxalicum Currie & Thom		Yes	No	Quarantine	Unknown			?
Penicillium puberulum Bainier		Yes	No	Quarantine	Unknown			?
Penicillium purpurogenum Stoll		Yes	No	Quarantine	Unknown			?
Penicillium roquefortii Thom		Yes	No	Quarantine	Unknown			?
Penicillium rugulosum Thom		Yes	No	Quarantine	Unknown			?
Penicillium sclerotiorum Van Beyma		Yes	No	Quarantine	Unknown			?
Penicillium thomii Maire		Yes	No	Quarantine	Unknown			?
Penicillium variabile Sopp		Yes	No	Quarantine	Unknown			?
Penicillium verrucosum Dierckx		Yes	No	Quarantine	Unknown			?
Penicillium viridicatum Westling		Yes	No	Quarantine	Unknown			?
Penicillium waksmanii Zaleski		Yes	No	Quarantine	Unknown			?
Perichaena vermicularis (Schwein.) Rostr.		Yes	Yes	Non-quarantine				
Periconia circinata (Mangin) Sacc.	root rot	Yes	Yes	Non-quarantine				
Periconia macrospinosa Lefebvre & Johnson in Lefebvre *et al.*		Yes	Yes	Non-quarantine				
Perisporium zeae Berk. & Curtis		Yes	No	Quarantine	Unknown			?
Peronosclerospora sorghi (Weston & Uppal) Shaw	sorghum downy mildew	Yes	No	Quarantine	yes	yes	High	yes
Phaeocytostroma ambiguum (Mont.) Petr. in Petr. & Syd.	Phaeocytosporella stalk infection	Yes	Yes	Non-quarantine				
Phaeosphaeria eustoma (Fuckel) Holm	Phaeosphaeria leaf spot	Yes	Yes	Non-quarantine				
Phaeosphaeria herpotricha (De Not) Holm	Phaeosphaeria leaf spot	Yes	Yes	Non-quarantine				
Phaeotrichoconis crotalariae (Salam & Rao) Subram.		Yes	Yes	Non-quarantine				
Phoma americana Morgan-Jones & White	root rot	Yes	No	Quarantine	Yes	no		
Phoma terrestris Hans.	pink root; stalk rot	Yes	Yes	Non-quarantine				
Phoma zeicola Ellis & Evrh.	root rot	Yes	No	Quarantine	Yes	no		

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Phomopsis sp.	Phomopsis seed rot	Yes	Yes	Non-quarantine				
Phycomyces nitens Kunze		Yes	Yes	Non-quarantine				
Phyllosticta maydis Arny & Nelson	yellow leaf blight	Yes	No	Quarantine	Yes	no		
Phyllosticta zeae Stout	Phyllosticta leaf spot	Yes	No	Quarantine	Yes	no		
Phymatotrichopsis omnivora (Duggar) Hennebert	root rot	Yes	No	Quarantine	Yes	yes	Low	Yes
Physalospora abdita (Berk. & Curtis) Stevens in Voorhees		Yes	No	Quarantine	Unknown			?
Physarum pusillum (Berk. & Curtis) List.	slime mould	Yes	Yes	Non-quarantine				
Physoderma maydis (Miyabe) Miyabe	brown spot of maize	Yes	Yes	Non-quarantine				
Physopella pallescens (Arth.) Cummins & Ramachar	leaf rust	Yes	No	Quarantine	Yes	no		
Phytophthora cactorum (Lebert & Cohn) Schroet.	root rot	Yes	Yes	Non-quarantine				
Phytophthora drechsleri Tucker	root rot	Yes	Yes	Non-quarantine				
Phytophthora nicotianae Breda de Haan var. ***parasitica*** (Dastur) Waterhouse	root rot	Yes	Yes	Non-quarantine				
Pithoascus intermedius (Emmons & Dodge) Arx		Yes	No	Quarantine	Unknown			?
Pithoascus schumachrei (Hans.) Arx		Yes	No	Quarantine	Unknown			?
Pithomyces maydicus (Sacc.) Ellis	ear rot	Yes	No	Quarantine	Yes	no		
Pleospora straminis Sacc. & Speg.		Yes	No	Quarantine	Unknown			?
Podospora minor Ellis & Everh.		Yes	No	Quarantine	Unknown			?
Polyschema olivacea (Ellis & Everh.) Ellis		Yes	No	Quarantine	Unknown			?
Puccinia polysora Underw.	southern rust	Yes	Yes	Non-quarantine				
Puccinia sorghi Schwein.	common maize rust	Yes	Yes	Non-quarantine				
Pyricularia grisea (Cooke) Sacc.	white leaf spot	Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Pyronema omphalodes (Bull.:Fr.) Fuckel		Yes	Yes	Non-quarantine				
Pythium acanthicum Drechs.	root rot	Yes	No	Quarantine	Yes	no		
Pythium adhaerens Sparrow	root rot	Yes	No	Quarantine	Yes	no		
Pythium angustatum Sparrow	root rot	Yes	No	Quarantine	Yes	no		
Pythium aphanidermatum (Edson) Fitzp.	Pythium stalk rot	Yes	Yes	Non-quarantine				
Pythium arrhenomanes Drechs.	root rot	Yes	Yes	Non-quarantine				
Pythium graminicola Subramanian	root rot	Yes	Yes	Non-quarantine				
Pythium irregulare Buisman	seedling blight, damping off	Yes	Yes	Non-quarantine				
Pythium myriotylum Drechs.	root rot	Yes	Yes	Non-quarantine				
Pythium paroecandrum Drechs.	root rot	Yes	Yes	Non-quarantine				
Pythium pulchrum Minden	root rot	Yes	No	Quarantine	Yes	no		
Pythium rostratum Butler	root rot	Yes	Yes	Non-quarantine				
Pythium splendens Braun	root rot	Yes	Yes	Non-quarantine				
Pythium sylvaticum Campbell & Hendrix	seed rot	Yes	No	Quarantine	Yes	no		
Pythium ultimum Trow	root rot	Yes	Yes	Non-quarantine				
Ramulispora sorghi (Ellis & Everh.) Olive & Lefebvre in Olive *et al.*	brown leaf spot	Yes	Yes	Non-quarantine				
Rhizoctonia solani Kühn	Rhizoctonia root rot	Yes	Yes	Non-quarantine				
Rhizoctonia zeae Voorhees	sclerotial rot	Yes	Yes	Non-quarantine				
Rhizopus arrhizus Fischer	Rhizopus ear rot	Yes	Yes	Non-quarantine				
Rhizopus microsporus Tiegh.	Rhizopus ear rot	Yes	No	Quarantine	Yes	no		
Rhizopus microsporus Tiegh. Var. ***rhizopodiformis*** (Cohn) Schipper	Rhizopus ear rot	Yes	No	Quarantine	Yes	no		

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Rhizopus stolonifer (Ehrenb.:Fr.) Vuill.	Rhizopus ear rot	Yes	Yes	Non-quarantine				
Rhopographus zeae Pat.	stalk rot	Yes	No	Quarantine	Yes	no		
Sclerophthora macrospora (Sacc.) Thirumalachar *et al*.	crazy top	Yes	Yes	Non-quarantine				
Sclerospora graminicola (Sacc.) Schröt.	Graminicola downy mildew; green ear	Yes	No	Quarantine	Yes	yes	Low	Yes
Sclerotinia sclerotiorum (Lib) de Bary	Sclerotinia stalk rot	Yes	Yes	Non-quarantine				
Sclerotium rolfsii Sacc.	Sclerotium ear rot	Yes	Yes	Non-quarantine				
Scopulariopsis brevicaulis (Sacc.) Bainier	ear rot	Yes	Yes	Non-quarantine				
Scopulariopsis brumptii Salvanet-Duval	ear rot	Yes	Yes	Non-quarantine				
Septoria zeae Stout	leaf spot	Yes	No	Quarantine	Yes	no		
Septoria zeicola Stout	leaf spot	Yes	Yes	Non-quarantine				
Septoria zeina Stout	leaf spot	Yes	No	Quarantine	Yes	no		
Sphaerella paulula Cooke		Yes	No	Quarantine	Unknown			?
Sporidesmium folliculatum (Corda) Mason & Hughes		Yes	No	Quarantine	Unknown			?
Sporisorium holci-sorghi (Rivolta) Vanky	head smut	Yes	Yes	Races?	Yes	Yes	High	?
Stachybotrys zeae Morgan-Jones & Karr		Yes	No	Quarantine	Unknown			?
Stauronema cruciferum (Ellis) Syd *et al*.		Yes	No	Quarantine	Unknown			?
Stenocarpella macrospora (Earle) Sutton	Diplodia ear and stalk rot	Yes	Yes	Non-quarantine				
Stenocarpella maydis (Berk.) Sutton	Diplodia ear and stalk rot	Yes	Yes	Non-quarantine				
Sterile white basidiomycete *(SWB)*	SWB root rot	Yes	No	Quarantine	Yes	no		
Stictis radiata Pers.:Fr.		Yes	No	Quarantine	Unknown			?
Stictis stellata Schwein.		Yes	Yes	Non-quarantine				
Syncephalastrum racemosum Cohn ex Schroet		Yes	Yes	Non-quarantine				
Talaromyces luteus (Zukal) Benjamin		Yes	No	Quarantine	Unknown			?

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Talaromyces stipitatus (Thom) Benjamin		Yes	No	Quarantine	Unknown			?
Thamnidium elegans Link:Fr		Yes	No	Quarantine	Unknown			?
Trichoderma koningii Oudem.		Yes	Yes	Non-quarantine				
Trichoderma viride Pers.:Fr.	Trichoderma ear rot	Yes	Yes	Non-quarantine				
Trichothecium roseum (Pers.:Fr.) Link	pink mould	Yes	Yes	Non-quarantine				
Tritirachium oryzae (Vincens) De Hoog		Yes	No	Quarantine	Unknown	No		
Tubeufia cylindrothecia (Seaver) Höhn		Yes	No	Quarantine	Unknown			?
Typhula phacorrhiza (Reichard:Fr.) Fr.	snow mould	Yes	No	Quarantine	Unknown			?
Ulocladium lanuginosum (Harz.) Simmons		Yes	No	Quarantine	Unknown			?
Ustilaginoidea virens (Cooke) Takah.	false smut	Yes	No	Quarantine	Yes	yes	Low	Yes
Ustilago zeae (Beckm.) Unger	boil smut	Yes	Yes (under official control)	Quarantine	Unknown			?
Verticillium tenerum (Pers.:Fr.) Link		Yes	Yes	Non-quarantine				
Wolfiporia cocos (Wolf) Ryvarden & Gilbertson	wood rot	Yes	No	Quarantine	Yes	no		
NEMATODES								
Belonolaimus longicaudatus Rau 1958	sting nematode	Yes	Yes	Non-quarantine				
Criconema mutabile (Taylor) Raski & Luc	ring nematode	Yes	Yes	Non-quarantine				
Ditylenchus dipsaci (Kuhn) Flipjev 1936	bulb and stem nematode	Yes	Yes	Non-quarantine				
Dolichodorus heterocephalus Cobb, 1914	awl nematode	Yes	No	Quarantine	Yes	Yes	Low	Yes
Filenchus exiguus (de Man) Ebsary		Yes	Yes	Non-quarantine				
Helicotylenchus multicinctus (Cobb) Golden 1956	spiral nematode	Yes	Yes	Non-quarantine				
Helicotylenchus multicinctus (Cobb) Sher 1956	spiral nematode	Yes	Yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Helicotylenchus pseudorobustus (Steiner) Golden 1956	spiral nematode	Yes	yes	Non-quarantine				
Heterodera avenae Wollenweber 1924	cereal cyst nematode	yes	yes	Non-quarantine				
Heterodera zeae Koshy *et al*. 1970	corn cyst nematode	Yes	No	Quarantine	Yes	Yes	Low	Yes
Hoplolaimus columbus Sher 1963	lance nematode	Yes	No	Quarantine	Yes	Yes	Low	Yes
Hoplolaimus galeatus (Cobb) Thorne 1935	lance nematode	Yes	No	Quarantine	Yes	No		
Longidorus breviannulatus Norton & Hoffman 1975	needle nematode	Yes	No	Quarantine	Yes	Yes	Low	Yes
Macroposthonia ornata (Raski) de Grisse & Loof, 1965	ring nematode	yes	yes	Non-quarantine				
Meloidogyne arenaria (Neal) Chitwood 1949	root-knot nematode	yes	yes	Non-quarantine				
Meloidogyne chitwoodi Golden *et al*. 1980	root-knot nematode	Yes	No	Quarantine	Yes	No		
Meloidogyne incognita (Kofold & White) Chitwood 1949	root-knot nematode	yes	yes	Non-quarantine				
Meloidogyne javanica (Treub) Chitwood 1949	root-knot nematode	yes	yes	Non-quarantine				
Nacobbus dorsalis Thorne & Allen		yes	no	Quarantine	Yes	No	Low	
Paratrichodorus christiei (Allen) Siddiqi 1974	stubby-root nematode	Yes	No	Quarantine	Yes	No		
Pratylenchus brachyurus (Godfrey) Filipjev & Schuurmans Stekhoven 1941	root lesion nematode	yes	yes	Non-quarantine				
Pratylenchus crenatus Loof	root lesion nematode	yes	yes	Non-quarantine				
Pratylenchus hexincisus Taylor & Jenkins 1957	root lesion nematode	yes	yes	Non-quarantine				
Pratylenchus neglectus (Rensch) Filipjev & Schuurmans Stekhoven 1941	root lesion nematode	yes	yes	Non-quarantine				
Pratylenchus penetrans (Cobb) Chitwood & Oteifa 1952	root lesion nematode	yes	yes	Non-quarantine				
Pratylenchus scribneri Steiner, 1943	root lesion nematode	Yes	No	Quarantine	Yes	Yes	Low	Yes
Pratylenchus thornei Sher & Allen 1953	root lesion nematode	yes	yes	Non-quarantine				
Pratylenchus zeae Graham 1951	root lesion nematode	yes	yes	Non-quarantine				

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Quinisulcius acutus (Allen) Siddiqi 1974	stubby-root nematode	Yes	No	Quarantine	Yes	No		
Radopholus similis (Cobb) Thorne 1949	burrowing nematode	yes	yes	Non-quarantine				
Rotylenchulus parvus (Williams) Sher 1961	reniform nematode	yes	yes	Non-quarantine				
Tylenchorhynchus dubius (Butschli) Filipjev 1936	stunt nematode	yes	yes	Non-quarantine				
Xiphinema americanum Cobb 1913	dagger nematode	yes	yes	Non-quarantine				
PHYTOPLASMAS								
Maize bushy stunt phytoplasma	maize bush stunt	yes	no	Quarantine	Unknown			?
Spiroplasma kunkelii Whitcomb *et al*	corn stunt	yes	no	Quarantine	Unknown			?
VIRUSES								
Barley yellow dwarf luteovirus (BSMV)	barley yellow dwarf	yes	yes	Non-quarantine				
Brome mosaic bromovirus (BMV)	brome mosaic	yes	yes	Non-quarantine				
Cucumber mosaic cucumovirus (CMV)	cucumber mosaic	yes	yes	Non-quarantine				
High Plains virus	High Plains disorder	yes	no	Quarantine	Yes	Yes	High	Yes
Johnsongrass mosaic potyvirus (JGMV)	Johnson grass mosaic	yes	yes	Non-quarantine				
Maize chlorotic dwarf waikavirus (MCDV)	maize chlorotic dwarf	yes	no	Quarantine	Unknown			?
Maize chlorotic mottle machlomovirus (MCMV)	maize chlorotic mottle	yes	no	Quarantine	Yes	Yes	High	Yes
Maize dwarf mosaic potyvirus (MDMV)	maize dwarf mosaic	yes	no	Quarantine	Yes	Yes	High	Yes
Maize mosaic nucleorhabdovirus (MMV)	maize mosaic	yes	no	Quarantine	Unknown			?
Maize rayado fino marafivirus (MRFV)	maize rayado fino	yes	no	Quarantine	Unknown	Yes		?
Maize stripe tenuivirus (MSpV)	maize stripe	yes	yes	Non-quarantine	Unknown			?
Maize white line mosaic satellivirus	maize white line mosaic	yes	no	Quarantine	Unknown			?

Pathogen	Disease	Present in USA	Present in Australia	Australian Quarantine Status	Present in Pathway	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Maize white line mosaic virus (MWLMV)	maize white line mosaic	yes	no	Quarantine	Unknown			?
Wheat streak mosaic rymovirus (WSMV)	wheat streak mosaic	yes	no	Quarantine	Yes	Yes	High	Yes
Wheat striate virus (WStMV)	wheat striate	yes	no	Quarantine	No			

Table 14.2. Quarantine status of pests associated with stored maize grain and admixture grain commodities and arthropod pests known to vector maize diseases in North America.

Economic pests that either do not occur on stored maize grain in Australia or are under official control are quarantine pests in accordance with the FAO definition of a quarantine pest. However, specific phytosanitary measures are only needed if the pest is associated with the part of the plant proposed to be imported, in this case the seeds. Taking account of this, the final column in the table identifies those pests which require quarantine management. Action, however, will be taken against any of the quarantine pests if found with the commodity on arrival in Australia.

Pest	Common name/s	Present in North America, Canada, USA or Mexico	Present in Australia	Australian Quarantine Status	Present on Pathway (seeds)	Potential Economic Impact	Probabillity of Introduction	Quarantine Management Required[2]
Acanthoscelides obtectus	bean weevil	North America	yes	Non-quarantine	yes	low		
Aceria tosichella	grass mite	USA	yes	Non-Quarantine	no	medium		
Aglossa caprealis	murky meal moth	USA	yes	Non-quarantine	yes	low		
Agriotes mancus	wheat wireworm	North America	no	Quarantine	no	medium	low	
Ahasverus advena	foreign grain beetle	Canada, USA	yes	Non-quarantine	yes	medium		
Alphitobius diaperinus	lesser mealworm	North America	yes	Non-quarantine	yes	low		
Alphitobius laevigatus	black fungus beetle	North America	yes	Non-quarantine	yes	low		
Alphitophagus bifasciatus	twobanded fungus beetle	Canada, USA	yes	Non-quarantine	yes	low		
Anthicus spp.	ant beetles	North America	yes	Non- quarantine	yes	low		
Anthrenus spp.	museum beetle, carpet beetle	North America	yes	Non-Quarantine	yes	low		
Attagenus spp.	black carpet beetle, fur beetle	North America	yes	Non-quarantine	yes	low		
Bruchus pisorum	pea weevil	Canada, USA	yes	Non-quarantine	yes	high		
Cadra cautella	tropical warehouse moth	North America	yes	Non-quarantine	yes	high		
Cadra figulilella	raisin moth	USA	yes	Non-quarantine	yes	medium		
Callosobruchus chinensis	southern cowpea weevil	possible in southern USA	no	Non-quarantine	yes	high	low	yes
Callosobruchus maculatus	cowpea weevil	USA	yes	Non-quarantine	yes	high		
Carpophilus spp.	sap beetles, dried fruit beetles	North America	yes	Non-quarantine	yes	low		

[2] Pests assessed as quarantine pests present in the pathway will be addressed by routine inspection procedures. The risks posed by these pests are reduced to negligibly low levels with a combination of inspection and management strategies which are outlined in other parts of this document.

Pest	Common name/s	Present in North America, Canada, USA or Mexico	Present in Australia	Australian Quarantine Status	Present on Pathway (seeds)	Potential Economic Impact	Probabillity of Introduction	Quarantine Management Required[2]
Cathartus quadricollis	square-necked flour beetle	USA-south, Mexico	no	Quarantine	yes	high	high	yes
Caulophilus oryzae	broadnosed grain weevil	SE USA, Mexico	no	Quarantine	yes	high	medium	yes
Chaetocnema pulicaria	corn flea beetle	North America	no	Quarantine	no	high		
Corcyra cephalonica	rice moth	USA, Mexico	yes	Non-quarantine	yes	high		
Corticaria spp.	minute mould beetle	North America	yes	Non-quarantine	yes	medium		
Cryptolestes ferrugineus	rusty grain beetle	North America	yes	Non-quarantine	yes	high		
Cryptolestes pusilleodes	flat grain beetle	Mexico	yes	Non-quarantine	yes	medium		
Cryptolestes pusillus	flat grain beetle	North America	yes	Non-quarantine	yes	medium		
Cryptolestes turcicus	flat grain beetle, flour mill beetle	Canada, USA	no	Quarantine	yes	high	medium	yes
Cryptophagus spp.		USA, Canada	yes	Non-quarantine	yes	medium		
Cynaeus angustus	large black flour beetle	Canada, Mexico, USA	no	Quarantine	yes	high	medium	yes
Dalbulus maidis	corn leafhopper	USA	no	Quarantine	no	medium		
Deinerella spp.		North America	yes	Non-quarantine	yes	low		
Delia platura	seed corn maggot	North America	yes	Non-quarantine	no	medium		
Dermestes spp.	hide beetles	North America	yes	Non-quarantine	yes	low		
Diabrotica sp.	corn rootworm	North America	yes	Non-quarantine	no	low		
Diabrotica longicornis	northern corn rootworm	Canada, USA	no	Quarantine	no	medium		
Diabrotica undecimpunctata	southern corn rootworm	Canada, USA	no	Quarantine	no	medium		
Diabrotica virgifera	western corn rootworm	USA	no	Quarantine	no	medium		
Dinoderus minutus	bamboo powderpost beetle	North America	yes	Non-quarantine	yes	medium		
Endrosis sarcitrella	whiteshouldered house moth	North America	yes	Non-quarantine	yes	low		
Enicumus minutus		USA, Canada	yes	Non-quarantine	yes	medium		
Ephestia elutella	tobacco moth	North America	yes	Non-quarantine	yes	high		
Ephestia kuehniella	Mediterranean flour moth	North America	yes	Non-quarantine	yes	high		

Pest	Common name/s	Present in North America, Canada, USA or Mexico	Present in Australia	Australian Quarantine Status	Present on Pathway (seeds)	Potential Economic Impact	Probabillity of Introduction	Quarantine Management Required[2]
Eriophyes tulipae	wheat curl mite	North America	yes	Non-quarantine	no	medium		
Exitianus exitosus	leafhopper	USA	no	Quarantine	no	medium		
Gibbium aequinoctiale	spider beetle	North America	yes	Non-quarantine	yes	low		
Gibbium psylloides	spider beetle	USA, Mexico	yes	Non-quarantine	yes	low		
Glischrochilus fasciatus	redspotted sap beetle, picnic beetle	Canada, USA	no	Quarantine	yes	high	medium	yes
Glischrochilus quadrisignatus	fourspotted sap beetle, picnic beetle	Canada, USA	no	Quarantine	yes	high	medium	yes
Gnatocerus cornutus	broadhorned four beetle	North America	yes	Non-quarantine	yes	low		
Graminella nigrifrons	grass leafhopper	USA	no	Quarantine	no	medium		
Graminella sonora	grass leafhopper	USA	no	Quarantine	no	medium		
Henoticus spp.		North America	yes	Non-quarantine	yes	low		
Hofmannophila pseudospretella	brown house moth	North America	yes	Non-quarantine	yes	low		
Lachesilla pedicularia	booklouse	North America	yes	Non-quarantine	yes	low		
Lachesilla quercus	booklouse	North America	yes	Non-quarantine	yes	low		
Lasioderma serricorne	cigarette beetle	North America	yes	Non-quarantine	yes	high		
Latheticus oryzae	longheaded flour beetle	North America	yes	Non-quarantine	yes	low		
Lathridius spp.	plaster beetle	North America	yes	Non-quarantine	yes	low		
Lema melanopa	cereal beetle	Canada, USA	no	Quarantine	no	medium		
Lepinotus inquilinus	booklouse	USA	yes	Non-quarantine	yes	medium		
Lepinotus patruelis	booklouse	USA	yes	Non-quarantine	yes	medium		
Liposcelis bostrychophila	booklouse	North America	yes	Non-quarantine	yes	medium		
Liposcelis brunnea	booklouse	USA	yes	Non-quarantine	yes	medium		
Liposcelis corrodens	booklouse	USA	yes	Non-quarantine	yes	medium		
Liposcelis decolor	booklouse	USA	yes	Non-quarantine	yes	medium		
Liposcelis entomolphila	booklouse	North America	yes	Non-quarantine	yes	low		
Liposcelis paeta	booklouse	North America	yes	Non-quarantine	yes	medium		
Liposcelis rufa	booklouse	USA	yes	Non-quarantine	yes	medium		
Litargus balteatus		Canada, USA	yes	Non-quarantine	yes	low		
Mezium affine	spiny spider beetle	North America	yes	Non-quarantine	yes	low		

Pest	Common name/s	Present in North America, Canada, USA or Mexico	Present in Australia	Australian Quarantine Status	Present on Pathway (seeds)	Potential Economic Impact	Probabillity of Introduction	Quarantine Management Required[2]
Mezium americanum	American spider beetle	North America	yes	Non-quarantine	yes	low		
Murmidius ovalis	murmidius beetle	Canada, USA	yes	Non-quarantine	yes	low		
Mycetophagus quadriguttatus	spotted hairy fungus beetle	Canada, USA	yes	Non-quarantine	yes	low		
Nemapogon granella	European grain moth	USA	yes	Non-quarantine	yes	low		
Niptus hololeucus	golden spider beetle	Canada, USA	yes	Non-quarantine	yes	low		
Oryzaephilus mercator	merchant grain beetle	North America	yes	Non-quarantine	yes	high		
Oryzaephilus surinamensis	sawtoothed grain beetle	North America	yes	Non-quarantine	yes	high		
Palorus ratzeburgii	broadhorned flour beetle	North America	yes	Non-quarantine	yes	low		
Palorus subdepressus	depressed flour beetle	North America	yes	Non-quarantine	yes	low		
Peregrinus maidis	corn planthopper	USA	yes	Non-quarantine	no	medium		
Pharaxanotha kirschi	Mexican grain beetle	USA, Mexico	no	Quarantine	yes	low	medium	yes
Phyllophaga spp.	May beetle	North America	no	Quarantine	no	medium		
Plodia interpunctella	Indian meal moth	North America	yes	Non-quarantine	yes	high		
Prostephanus truncatus	larger grain borer, greater grain borer	USA-south, Mexico	no	Quarantine	yes	high	medium	yes
Pseudeurostus hilleri		Canada, USA	yes	Non-quarantine	yes	low		
Psocathropos microps		USA	yes	Non-quarantine	yes	low		
Ptinus spp.	spider beetles	North America (temperate regions)	yes	Non-quarantine	yes	low		
Pyralis farinalis	meal moth	Canada, USA	yes	Non-quarantine	yes	medium		
Rhopalosiphum maidis	corn leaf aphid	North America	yes	Non-quarantine	no	medium		
Rhopalosiphum padi	bird cherry-oat aphid	North America	yes	Non-quarantine	no	medium		
Rhyzopertha dominica	lesser grain borer	North America	yes	Non-quarantine	yes	high		
Sitophilus granarius	granary weevil	Canada, USA	yes	Non-quarantine	yes	high		
Sitophilus oryzae	rice weevil	North America	yes	Non-quarantine	yes	high		

Pest	Common name/s	Present in North America, Canada, USA or Mexico	Present in Australia	Australian Quarantine Status	Present on Pathway (seeds)	Potential Economic Impact	Probabillity of Introduction	Quarantine Management Required[2]
Sitophilus zeamais	maize weevil	North America	yes	Non-quarantine	yes	high		
Sitotroga cerealella	angoumois grain moth	USA, Mexico	yes	Non-quarantine	yes	low		
Stegobium paniceum	drugstore beetle	North America	yes	Non-quarantine	yes	medium		
Tenebrio molitor	yellow mealworm	North America	yes	Non-quarantine	yes	low		
Tenebrio obscurus	dark mealworm	North America	yes	Non-quarantine	yes	low		
Tenebroides mauritanicus	cadelle	Canada, USA	yes	Non-quarantine	yes	low		
Tineola bisselliella	common clothes moth	USA	yes	Non-quarantine	yes	low		
Tortricidae spp.	budworm	North America	yes	Non-quarantine	no	medium		
Tribolium audax	American black flour beetle	Canada, USA	no	Quarantine	yes	medium	medium	yes
Tribolium brevicorne	flour beetle	Canada, USA	no	Quarantine	yes	low	medium	yes
Tribolium castaneum	red flour beetle	North America	yes	Non-quarantine	yes	high		
Tribolium confusum	confused flour beetle	North America	yes	Non-quarantine	yes	high		
Tribolium destructor	large flour beetle	Canada, USA	no	Quarantine	yes	high	medium	yes
Tribolium madens	black flour beetle	Canada, USA	no	Quarantine	yes	high	medium	yes
Trigonogenius globulus	globular spider beetle	Canada, USA	yes	Non-quarantine	yes	low		
Trogoderma glabrum	glaberous cabinet beetle	Canada, Mexico, USA	no	Quarantine	yes	low	high	yes
Trogoderma granarium	khapra beetle	not present but interceptions recorded	no	Quarantine	yes	high	high	yes
Trogoderma inclusum	large cabinet beetle, mottled dermestid	Canada, USA	no	Quarantine	yes	high	high	yes
Trogoderma ornatum	ornate cabinet beetle	USA	no	Quarantine	yes	low	high	yes
Trogoderma variabile	warehouse beetle	USA	yes (under official control in WA)	Quarantine	yes	high	high	yes
Typhaea stercorea	hairy fungus beetle	North America	yes	Non-quarantine	yes	low		
Zabrotes subfasciatus	Mexican bean beetle	southern USA, Mexico	no	Non-quarantine	yes	high	low	yes

Table 14.3: Quarantine status of weed species associated with maize grain imported from the USA.

Weed	Common name/s	Present in USA	Present in Australia	Australian Quarantine Status	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Abutilon theophrasti (herbicide resistant)	velvet leaf	yes	no	Quarantine	high	medium	yes
Acanthospermum hispidum	star burr, goat's head	yes	yes*	Quarantine	medium-high	high	yes
Aeschynomene virginica	Northern jointvetch	yes	no	Quarantine	medium-high	medium	yes
Agropyron repens	quackgrass	yes	yes	Non-quarantine			
Alopecurus myosuroides	slender foxtail	yes	yes	Non-quarantine			
Amaranthus albus	tumble pigweed	yes	yes	Non-quarantine			
Amaranthus arenicola	sandhills amaranth	yes	no	Quarantine	high	low	yes
Amaranthus chlorostachys		yes	no	Quarantine	high	low	yes
Amaranthus hybridus	smooth pigweed	yes	yes	Non-quarantine			
Amaranthus hybridus (triazine resistant)	smooth pigweed	yes	no	Quarantine	high	high	yes
Amaranthus palmeri (herbicide resistant)	palmer amaranth	yes	no	Quarantine	high	high	yes
Amaranthus retroflexus	redroot pigweed	yes	yes	Non-quarantine			
Amaranthus retroflexus (triazine resistant)	redroot pigweed	yes	no	Quarantine	high	high	yes
Amaranthus rudis (triazine resistant)	common waterhemp	yes	no	Quarantine	high	high	yes
Amaranthus tamariscinus	pigweed	yes	no	Quarantine	high	low	yes
Ambrosia artemisiifolia	common ragweed	yes	yes*	Quarantine	low-medium	high	yes
Ambrosia trifida	giant ragweed	yes	no	Quarantine	medium-high	high	yes
Ampelamus albidus	honeyvine milkweed	yes	no	Quarantine	medium	medium	yes
Anoda cristata	spurred anoda	yes	yes	Non-quarantine			
Apocynum cannabinum	hemp dogbane	yes	no	Quarantine	high	high	yes
Artemisia annua	wormwood	yes	yes	Non-quarantine			
Asclepias syriaca	common milkweed	yes	no	Quarantine	high	medium	yes
Avena fatua	wild oat	yes	yes	Non-quarantine			
Avena sativa	oat	yes	yes	Non-quarantine			
Barbarea vulgaris	wintercress	yes	yes	Non-quarantine			
Berteroa incana	hoary Alison	yes	no	Quarantine	medium	low	yes
Bidens aurea		yes	no	Quarantine	low	low	yes
Brachiaria platyphylla	broadleaf signalgrass	yes	no	Quarantine	high	high	yes
Brassica japonica	wild mustard	yes	no	Quarantine	medium	low	yes
Brassica kaber	charlock	yes	yes	Non-quarantine			
Brassica nigra	black mustard	yes	yes	Non-quarantine			

Weed	Common name/s	Present in USA	Present in Australia	Australian Quarantine Status	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Bromus tectorum	downy brome, drooping brome	yes	no	Quarantine	medium	high	yes
Brunnichia ovata	redvine	yes	no	Quarantine	medium	medium	yes
Calystegia sepium	hedge bindweed	yes	yes	Non-quarantine			
Campsis radicans	trumpet creeper	yes	yes	Non-quarantine			
Cardiospermum halicacabum	balloonvine	yes	yes	Non-quarantine			
Cenchrus incertus	spiny burgrass	yes	yes*	Quarantine	medium-high	medium	yes
Cenchrus longispinus	longspine sandbur	yes	yes*	Quarantine	medium-high	medium	yes
Chenopodium album	common lambsquaters	yes	yes	Non-quarantine			
Chenopodium album (atrazine resistant)	fathen	yes	no	Quarantine	medium-high	high	yes
Cirsium arvense	Canada thistle, perennial thistle	yes	yes*	Quarantine	medium-high	high	yes
Citrullus vulgaris var. *citroides*	wild watermelon	yes	yes	Non-quarantine			
Cocculus carolinus	redberry moonseed	yes	no	Quarantine	medium	low	yes
Conringia orientalis	hare’s ear	yes	yes*	Quarantine	medium	low	yes
Convolvulus arvensis (herbicide resistant)	field bindweed	yes	no	Quarantine	high	medium	yes
Conyza canadensis	horseweed	yes	yes	Non-quarantine			
Cynodon dactylon	bermuda grass	yes	yes	Non-quarantine			
Cyperus esculentus	yellow nutgrass	yes	yes*	Quarantine	high	high	yes
Cyperus rotundus	purple nutsedge	yes	yes*	Quarantine	high	high	yes
Datura inoxia	downy thornapple	yes	yes*	Quarantine	low-medium	low	yes
Datura inoxia (resistant to ALS herbicides)	downy thornapple	yes	no	Quarantine	medium	low	yes
Datura stramonium	jimsonweed	yes	yes*	Quarantine	high	high	yes
Daucus carota	wild carrot	yes	yes*	Quarantine	low	low	yes
Desmodium tortuosum	Florida beggarweed	yes	yes	Non-quarantine			
Digitaria ischaemum	smooth summer grass	yes	yes	Non-quarantine			
Digitaria sanguinalis	crabgrass	yes	yes	Non-quarantine			
Echinochloa colonum	awnless barnyard grass	yes	yes	Non-quarantine			
Echinochloa crus-galli	barnyard grass	yes	yes	Non-quarantine			
Echinochloa crus-galli (herbicide resistant)	barnyard grass	yes	no	Quarantine	high	high	yes
Eleusine indica	goosegrass	yes	yes	Non-quarantine			
Equisetum arvense	common horsetail	yes	yes*	Quarantine	medium	medium	yes

Weed	Common name/s	Present in USA	Present in Australia	Australian Quarantine Status	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Eragrostis cilianensis	stinkgrass	yes	yes	Non-quarantine			
Eriochloa villosa	woolly cupgrass	yes	no	Quarantine	high	medium	yes
Elytrigia repens	quackgrass	yes	yes	Non-quarantine			
Eupatorium capillifolium	dog fennel	yes	no	Quarantine	low	medium	yes
Euphorbia supina	prostrate spurge	yes	yes*	Quarantine	medium	medium	yes
Helianthus annuus (herbicide resistant)	sunflower	yes	no	Quarantine	low	medium	yes
Hibiscus trionum	venice mallow	yes	yes	Non-quarantine			
Ipomoea hederacea	entireleaf morningglory, ivyleaf morningglory	yes	yes*	Quarantine	high	high	yes
Ipomoea lacunosa	morningglory	yes	no	Quarantine	high	high	yes
Ipomoea purpurea	tall morningglory	yes	yes*	Quarantine	high	high	yes
Ipomoea turbinata	morningglory	yes	no	Quarantine	high	low	yes
Jacquemontia tamnifolia	morningglory	yes	no	Quarantine	medium	low	yes
Kochia scoparia	kochia	yes	yes*	Quarantine	medium-high	high	yes
Lamium amplexicaule	hen bit	yes	yes	Non-quarantine			
Lolium multiflorum (herbicide resistant)	Italian ryegrass	yes	no	Quarantine	high	medium	yes
Lychnis alba	white campion	yes	yes	Non-quarantine			
Malva neglecta	dwarf mallow	yes	yes	Non-quarantine			
Melochia corchorifolia	redweed	yes	yes	Non-quarantine			
Mollugo verticillata	Indian chickweed	yes	yes	Non-quarantine			
Muhlenbergia frondosa	wirestem muhlys	yes	no	Quarantine	medium	low	yes
Panicum capillare	witchgrass	yes	yes	Non-quarantine			
Panicum capillare (herbicide resistant)	witchgrass	yes	no	Quarantine	medium	medium	yes
Panicum dichotomiflorum	fall panicum	yes	no	Quarantine	medium	high	yes
Panicum fasciculatum		yes	no	Quarantine	medium	medium	yes
Panicum miliaceum	wild proso millet	yes	yes	Non-quarantine			
Panicum racemosum		yes	yes	Non-quarantine			
Panicum ramosum		yes	no	Quarantine	medium	low	yes
Panicum texanum	Texas panicum	yes	no	Quarantine	medium	medium	yes
Paspalum ciliatifolium		yes	yes	Non-quarantine			
Paspalum dilatatum	paspalum	yes	yes	Non-quarantine			
Passiflora incarnata	mayhop passionfruit	yes	yes	Non-quarantine			
Poa pratensis	kentucky bluegrass	yes	yes	Non-quarantine			

Weed	Common name/s	Present in USA	Present in Australia	Australian Quarantine Status	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Polygonum aviculare	knotweed	yes	yes*	Quarantine	medium-high	medium	yes
Polygonum convolvulus	knotweed	yes	yes*	Quarantine	medium-high	medium	yes
Polygonum lapathifolium	knotweed	yes	yes*	Quarantine	medium-high	low	yes
Polygonum pensylvanicum	Pennsylvania smartweed	yes	yes*	Quarantine	high	high	yes
Portulaca oleracea	pigweed	yes	yes	Non-quarantine			
Raphanus raphanistrum	wild radish	yes	yes*	Quarantine	high	high	yes
Richardia scabra		yes	yes	Non-quarantine			
Rottboellia cochinchinensis	itchgrass	yes	yes	Non-quarantine			
Rottboellia exaltata	itchgrass	yes	yes	Non-quarantine			
Rubus allegheniensis	wild blackberry	yes	no	Quarantine	medium	low	yes
Rubus fruticosus	blackberry	yes	yes*	Quarantine	medium	low	yes
Rumex crispus	curled dock	yes	yes	Non-quarantine			
Salsola collina	tumble thistle	yes	no	Quarantine	medium-high	low	yes
Salsola iberica	thistle	yes	no	Quarantine	medium-high	high	yes
Salsola kali	Russian thistle	yes	yes*	Quarantine	medium-high	high	yes
Salvia reflexa	mintweed	yes	yes*	Quarantine	low-medium	low	yes
Senecio vulgaris	common groundsel	yes	yes*	Quarantine	medium	high	yes
Senna obtusifolia	Java bean	yes	yes*	Quarantine	high	high	yes
Senna occidentalis		yes	yes	Non-quarantine			
Sesbania exaltata	Hemp sesbania	yes	yes	Non-quarantine			
Setaria faberi	giant foxtail	yes	no	Quarantine	medium	high	yes
Setaria glauca	yellow foxtail	yes	yes	Non-quarantine			
Setaria italica	foxtail	yes	yes	Non-quarantine			
Setaria lutescens (herbicide resistant)	foxtail	yes	no	Quarantine	medium	medium	yes
Setaria verticillata	foxtail	yes	yes*	Quarantine	medium	low	yes
Setaria viridis	foxtail	yes	yes	Non-quarantine			
Sicyos angulatus	burcucumber	yes	no	Quarantine	high	high	yes
Sida spinosa	prickly sida	yes	yes	Non-quarantine			
Sinapis arvensis	charlock	yes	yes	Non-quarantine			
Solanun nigrum	black nightshade	yes	yes	Non-quarantine			
Solanum sarrachoides	nightshade	yes	yes	Non-quarantine			
Solanum ptycanthum	eastern black nightshade	yes	no	Quarantine	medium-high	high	yes
Sorghum x almum	Columbus grass	yes	yes*	Quarantine	medium	low	yes

Weed	Common name/s	Present in USA	Present in Australia	Australian Quarantine Status	Potential Economic Impact	Probability of Introduction	Quarantine Management Required
Sorghum bicolor	shattercane	yes	yes	Non-quarantine			
Sorghum halepense	johnson grass	yes	no	Quarantine	high	high	yes
Stellaria media	common chickweed	yes	yes	Non-quarantine			
Striga asiatica	witchweed	yes	no	Quarantine	high	low	yes
Taraxacum officinale	dandelion	yes	yes	Non-quarantine			
Verbesina encelioides	crownbeard	yes	yes*	Quarantine	medium	low	yes
Xanthium pensylvanicum	cocklebur	yes	yes*	Quarantine	high	high	yes
Xanthium spinosum	common cocklebur	yes	yes*	Quarantine	high	high	yes
Xanthium strumarium	noogoora burr	yes	yes*	Quarantine	high	high	yes
Xanthium strumarium. (resistant to imidazolinone)	noogoora burr	yes	no	Quarantine	high	medium	yes

* Regulated taxa in Australia by AQIS or State Legislation

15. APPENDIX 3: Glossary of Acronyms used in this report

AFFA	Agriculture, Fisheries and Forestry - Australia
APHIS	Animal and Plant Health Inspection Service
AQIS	Australian Quarantine and Inspection Service
CSIRO	Commonwealth Scientific and Industrial Research Organisation
FAO	Food and Agriculture Organisation
FGIS	Federal Grain Inspection Service
IPPC	International Plant Protection Convention
IRA	Import Risk Analysis
ISPM	International Standards for Phytosanitary Measures
RAP	Risk Assessment Panel
SPS	Sanitary and Phytosanitary
TWG	Technical Working Group
USA	United States of America
USDA	United States Department of Agriculture
WRA	Weed Risk Assessment
WTO	World Trade Organisation