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Report of a Pest Risk Analysis for *Parthenium hysterophorus*

This summary presents the main features of a pest risk analysis which has been conducted on the pest, according to EPPO Decision support scheme for quarantine pests (PM 5/3(5)).

Pests: ***Parthenium hysterophorus***

PRA area: EPPO region

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Date: The Expert Working group for PRA was held on 2013-07-02/05.
Core members (Mr Alan MacLeod, Ms Petter, Ms Suffer, Mr Ahmed Uludag and Ms Nursen Ustun) reviewed the draft PRA between March and April 2014.
The PRA was reviewed by the Panel on Invasive Alien plants in May 2014.

Parthenium hysterophorus, Picture Tuvia Yaacoby, Plant Protection and Inspection Services of Israel

STAGE 1: INITIATION

Reason for doing PRA: *Parthenium hysterophorus* (Asteraceae) is an annual plant (or short-lived perennial under certain growth conditions) native to the subtropics of North and South America. The plant has been introduced accidentally to Australia, and to many countries in Africa, Asia and the Pacific where it is considered invasive. Within the EPPO region, its distribution is still limited, as occurrence has only officially been reported in Israel so far in the Bet Shean Valley area (Dafni & Heller, 1982). It has also been

recorded in Egypt (Boulos & El-Hadidi, 1984), but information on its exact situation in this country is lacking. The species is recorded as casual in Belgium (Verloove, 2006) and Poland (Mirek *et al.*, 2002).
Because *P. hysterophorus* has shown invasive behaviour where it has been introduced elsewhere in the world and has a highly restricted distribution in the EPPO region, it can be considered an emerging invader in the EPPO region. *P. hysterophorus* has been determined as a priority for Pest Risk Analysis according to the EPPO Prioritization process for invasive alien plants (EPPO, 2012).

Taxonomic position of pest: Reign: Plantae; Family: Asteraceae; Genus: Parthenium; Species: *Parthenium hysterophorus* L.

STAGE 2: PEST RISK ASSESSMENT

PROBABILITY OF INTRODUCTION

Entry

Geographical distribution:
(see PRA record for references)

The known global distribution of *Parthenium hysterophorus* is as shown in Fig. 1 and all references are available in the full EPPO PRA on *Parthenium hysterophorus*.

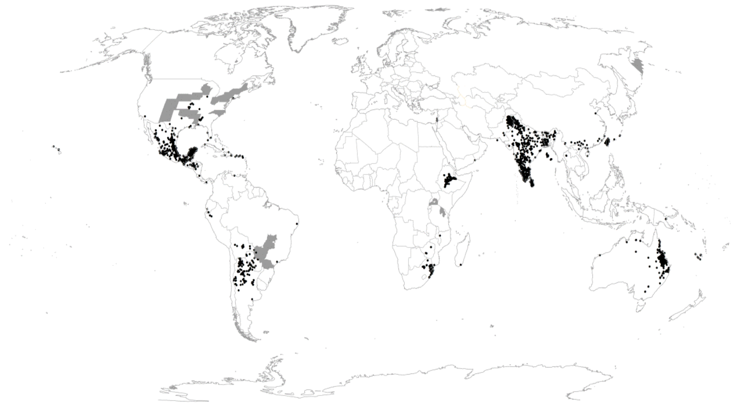

Fig. 1 - Known global distribution of *Parthenium hysterophorous* aggregated by Darren Kriticos.

Native distribution
P. hysterophorus is native to the area bordering the Gulf of Mexico, and has spread throughout southern USA, the Caribbean and Brazil.

North America: Bermuda, Mexico, USA (Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Hawaii, Illinois, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Missouri, Mississippi, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Virginia).
Central America and Caribbean: Belize, Costa Rica, Cuba, Dominican Republic, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Netherlands Antilles, Nicaragua, Puerto Rico, Saint Barthelemy, Republic of Panama, Trinidad, Trinidad and Tobago.
South America: Argentina, Bolivia, Brazil, Chile, Ecuador, French Guiana, Guyana, Peru, Paraguay, Suriname, Uruguay, Venezuela.

Exotic distribution
EPPO region: Israel.

Note: The species is recorded as casual in Belgium (Verloove, 2006) in 1999 in the Ghent port area (a single plant) and in 2013 in the port of Roeselare (several individuals). It is suspected that these plants did not maintain (no ripe fruits had been observed in November 2013) and that the species was introduced respectively as a contaminant of cereals or of soybean consignments and as a contaminant of birdseed or other petfood. *P. hysterophorus* has also been recorded as casual in Poland in 1938 (Mirek *et al*., 2002; Urbisk, 2011), but no detail is provided on its possible introduction.

Africa: Comores, Egypt, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Mauritius, Mayotte, Mozambique, Reunion, Seychelles, Somalia, South Africa, Swaziland, Tanzania, Uganda and Zimbabwe.

Note: due to its inconspicuous appearance, the species may well be present but unreported in additional African countries, or other countries.

Asia: Bangladesh, Bhutan, China (south of country), India, Oman and Yemen, Israel, Nepal, Pakistan, Sri Lanka, Japan, Republic of Korea, Taiwan and Vietnam.

Oceania: Australia (Queensland, New South Wales, Northern Territory, Western Australia), French Polynesia, several Pacific islands including Bermuda, New Caledonia, Vanuatu and Christmas island.

Note: the species was recorded from Papua New Guinea but has been declared as eradicated.

<u>Major host plants or habitats:</u>
(see PRA record for references)

P. hysterophorus grows in a wide range of habitats, including degraded and disturbed lands and streams and rivers. It is a pioneer species that can invade grazing land and degraded pastures, crops, orchards, summer crops, disturbed and cultivated areas, forests, railway tracks and roadsides, recreation areas, as well as river banks and floodplains (Navie *et al*. 1996a).

According to the Corine Land Cover nomenclature, the following habitats are invaded: arable land, permanent crops (e.g. vineyards, fruit tree and berry plantations, olive), pastures, riverbanks / canalsides (dry river beds), road and rail networks and associated land, other artificial surfaces (wastelands).

<u>Which pathway(s) is the pest likely to be introduced on:</u>

Entries as a contaminant of agricultural produce and machinery have historically been important pathways for the introduction of *P. hysterophorus* in new regions.

- **Contaminant of used machinery** (<u>Moderately likely, Level of uncertainty: low)</u>

P. hysterophorus can enter new territories as a contaminant of used machinery, either as seeds, e.g. lodged on the radiators and grills of automobiles, or as seeds in soil attached to machinery, such as harvesters, road construction and maintenance machinery, military equipment and other vehicles. Vehicles and harvesters may circulate quite frequently across EPPO countries. The release of seeds of *P. hysterophorus* from the vehicles on the roads networks may facilitate its transfer to other unintended habitats connected by roads.

- **Contaminant of grain** (<u>Moderately likely, Level of uncertainty: low)</u>

ISPM 5 defines grain as *"a commodity class for seeds intended for processing or consumption but not for planting (see seeds)*" (ISPM 5).

P. hysterophorus was accidentally introduced into Israel in 1980 most likely through import of contaminated grains from the USA for fishponds (Dafni & Heller 1982). Wheat and other cereals were reported for the introduction of *P. hysterophorus* in India (Sushilkumar & Varshney, 2010), and sorghum is also reported to be infested in Ethiopia (Tamado *et al*., 2002).

All spring cereals may be affected (wheat, sorghum, millet, oat, rye, barley) as well as maize. In the USA, *P. hysterophorus* is not a major weed because of unfavourable temperate climatic conditions, of the extensive use of herbicide in crops and of tillage and cultivation practices (Reddy & Bryson, 2005). In spite of these measures, almost all known reported introductions of the species occurred via infested consignments of grain originating from the USA. The EPPO region imports large quantities of cereal grain from the USA. Where contaminated grain is destined for processing, it is possible that *P. hysterophorus* seeds will be dispersed through 'leakage' during transport by road or railway. When contaminated grain is destined for animal feed, the seeds of *P. hysterophorus* ingested by animals could be spread to suitable habitats (e.g. pastures).

- **Contaminant of seed** (<u>Moderately likely, Level of uncertainty: medium)</u>

ISPM 5 defines seeds as "*a commodity class for seeds for planting or intended for planting and not for consumption or processing*"

The following seed have been suspected to be contaminated with *P. hysterophorus*:

- Pasture seeds (grass) from Texas into central Queensland (Everist, 1976), as well as in Egypt from Texas in the 1960s (Boulos & El-Hadidi, 1984);
- Cereal seed from the United States in Africa, Asia and Oceania (Bhomik & Sarkar, 2005);
- Soybean seed from the USA in the Shandong Province in China in 2004 (Li & Gao, 2012).

Although management practices are limiting the prevalence of *P. hysterophorus*, in particular with the use of herbicides, they may not totally remove the species from the fields in which seeds for sowing are produced, and therefore from the commodity. Where infested seed consignments are planted, transfer will happen to a suitable habitat, unless it is detected and removed before planting occurs.

- **Contaminant of growing media adherent to plants for planting** (<u>Moderately likely, Level of uncertainty: medium)</u>

P. hysterophorus is considered to spread locally as a contaminant of potting mix/soil coming along the movement of ornamental plants (trade) in Pakistan (Shabbir *et al*., 2013). *P. hysterophorus* would be able to form large stands in and around production areas, producing large amounts of seeds spread by wind and water. Although the species could be quite easily controlled with targeted sprays of herbicides, it is usually uncommon to use herbicides in nurseries in this way. Plants for planting will then be planted in suitable habitats for the pest.

- **Contaminant of travellers (tourists, migrants, etc.) and their clothes, shoes and luggage** (<u>Moderately likely, Level of uncertainty: high)</u>

Seed dispersal in mud adhering to human feet has been observed in Sri Lanka (Jayasuriya, 2005). Seeds are less than 2 mm and could be present on travellers' foot wear, as well as in their clothes and luggage. Movement of people is easy within the EPPO region. Footwear could then spread the plant on roadsides, fallow lands, etc. which are suitable habitats for the species.

Establishment

Plants at risk in the PRA area:

P. hysterophorus is a pioneer species that invade a wide variety of habitats:
- Grazing land;
- Cultivated areas and in particular summer crops which are the most at risk due to the phenology of *P. hysterophorus*; in dryland cropping, it has been reported in sorghum, sunflower and wheat crops in Australia, cereal crops, cotton, maize, pearl millet, oil seeds, potatoes, pulses, soybeans, sunflower in India, vegetables and fruits such as melons in Pakistan, etc. It has also been recorded in annual and perennial irrigated crops, such as in alfalfa, clover, tomatoes, cotton and forage fields in Israel;
- Disturbed and cultivated areas, roadsides, recreation areas;
- River banks and floodplains.

Climatic similarity of present distribution with PRA area (or parts thereof):

A CLIMEX projection model was performed during the EWG and identified that the whole Mediterranean basin as well as the surroundings of the Black sea and eastern Asia are highly suitable for the establishment of *P. hysterophorus* (see Fig. 2).

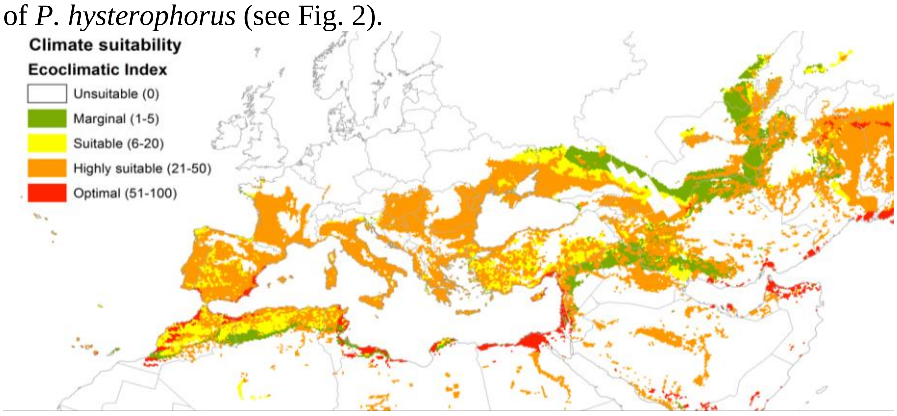

Fig. 2 - Climate suitability for *Parthenium hysterophorous* in the EPPO region modelled using CLIMEX with the CM10_1975H_WO_V1.1 climate dataset (Kriticos *et al.*, 2012), including the effect of irrigation (Siebert *et al.*, 2005).

Characteristics (other than climatic) of the PRA area that would favour establishment:

Irrigation in arid areas may allow the establishment of the species and therefore increase its potential distribution range as it has been observed in southern Pakistan (Shabbir, 2012).
Furthermore, the distribution and abundance of *P. hysterophorus* may be affected markedly by land use, since it favours open habitats subject to a relatively high frequency of disturbance (Navie *et al.*, 1996a; Dale, 1981).

Which part of the PRA area is the area of potential establishment:

Where climatic conditions are appropriate (e.g. Mediterranean area, Black Sea, Eastern Asia, the warmest temperate area) there are numerous suitable habitats. Consequently, for these areas, the probability of establishment is high with low uncertainty.

POTENTIAL ECONOMIC CONSEQUENCES

How much economic impact does the pest have in its present distribution:

P. hysterophorus has overall major economic impacts (including social impacts), due to its impacts on pastures and crops, but this species also has health impacts on humans and animals. There are many publications documenting the impacts of *P. hysterophorus* in numerous crops and habitats.

Describe damage to potential hosts/habitats in PRA area:

Impact upon cropping

Crop losses are reported to be primarily through allelopathic effects over and above the ability of *P. hysterophorus* to compete for nutrients and moisture. Direct effects arise owing to allelopathy (allelopathogenicity) resulting from the release of a wide variety of substances, which variously inhibit the growth of a number of crops, thus causing yield reductions (Swaminathan *et al.*, 1990). In irrigated sorghum, the presence of *P. hysterophorus* reduced grain yield from 6.47 to 4.25 t/ha and decreased grain weight by almost 30% (Channappagoudar *et al.*, 1990). In India, yield losses to *P. hysterophorus* in upland rice has been reported as ranging from 41 to 100% and averaging 79% (Mathews & Sarkar, 2005).

Indirect effects occur through interference with the reproduction of crop plants, as when pollen of *P. hysterophorus* is deposited upon floral stigmatic surfaces (Jayachandra, 1980), which prevents seed set with resulting losses in yields of up to 40% (Wise *et al*., 2007).

As another indirect effect upon crop production, *P. hysterophorus* acts as a reservoir host for plant pathogens and insect pests of crop plants (Basappa, 2005; Govindappa *et al*., 2005; Prasada Rao *et al*., 2005; Lakshmi & Srinivas, 2007). It has for example been recorded as a secondary host for the bacterial pathogen *Xanthomonas campestris* pv. *phaseoli*, (Ovies & Larrinaga, 1988) as well as for the viruses *Groundnut bud necrosis virus* (Prasada Rao *et al*., 2005), *Tomato yellow leaf curl virus* (Govindappa *et al*., 2005). It also serves as a reservoir for insect pests of crop plants between cropping seasons: *Maconellicoccus hirsutus*) (EPPO A2 pest) (Saxena *et al*., 2010), *Ferrisia virgata*, *Helicoverpa armigera* (EPPO A2 List), *Spilarctia oblique* and *Spodoptera litura* (EPPO A1 List) (Prof. Ramashandra Prasad, pers. com., 2013).

Orchards (stone fruits, cherries, olives, citrus spp. and other fruits) and vineyards (*Vitis vinefera*) are important crops in the EPPO countries that are at risk (i.e. Spain, Italy, Morocco). Although not demonstrated on these crops, *P. hysterophorus* could incur competition problems in the first years of planting and have major indirect effect by affecting fruiting through pollen allelopathy (Ramashandra Prasad *et al*., 2010).

Though, impacts on crop yield and/or quality depend upon the production used, as *P. hysterophorus* impacts may be kept to an acceptable level in intensive production areas, but can be major in extensive production areas.

Fig 3: Invasion of *Parthenium hysterophorus* in pastures in Queensland (http://www.getfarming.com.au)

Impact upon pastures

P. hysterophorus is a serious problem in perennial grasslands in Ethiopia (Ayele, 2007), India (Sushikumar & Varshney, 2010), Nepal (Timsina *et al*., 2010), the USA (Ruddy & Bryson, 2005), Pakistan (Khan, 2012) and in particular in Australia (central Queensland), where it reduces beef production by as much as AU$16.5 m annually in the early 1980s, owing to reduced stock numbers and live weight gains, as well as additional production and control costs (Chippendale & Panetta, 1994) (see Fig. 3).

P. hysterophorus develops particularly well in overgrazed pastures, and in Mediterranean overgrazing commonly occurs.

Environmental impact

P. hysterophorus is an environmental weed that can impact upon native grasslands, the understorey of open woodlands and along rivers and floodplains (Chippendale & Panetta, 1994). McFayden (1992) has reported a total habitat change in Australian grassland, open woodlands, river banks and floodplains caused by *P. hysterophorus*. One of the major detrimental effects of *P. hysterophorus*, and a potentially important contributor to its aggressiveness, is its allelopathic effects on other plants (Navie *et al*., 1996b).

Except on the soils most favourable for the species and under suitable climatic conditions, *P. hysterophorus* is unlikely to attain high densities in the absence of high levels of disturbance. Environmental impacts of *P. hysterophorus* are therefore expected to remain minor to moderate.

How much economic impact would the pest have in the PRA area:
Major
Level of uncertainty: medium

Impact upon cropping and pastures
Depending on the countries productions, the impacts may be minor (for crop producing countries such as France) or major for countries relying on pastural and vegetable productions (e.g. Morocco, Spain).
The impacts of *P. hysterophorus* in pastures in the EPPO countries at risk are expected to be similar as in other countries where the plant occurs (i.e. Queensland, India) and would be major as very few control measures are possible.

Fig. 4: Contact Dermatitis to *P. hysterophorus* (http://www.mmc.tn.gov.in/Department/OCD/services.html)

Impacts upon human and animal health
In addition to agricultural impacts, one of the most detrimental effects of *P. hysterophorus* is on human health. Most severe human health impact have been reported in India and Australia (Sharma & Sethuraman, 2007). Sushilkumar & Varshney (2010) reported that approximately 880 million INR were spent annually for the treatment of medical problems arising from exposure to *P. hysterophorus*. It was concluded that 50% of the exposed population (direct contact) became allergic (e.g. dermatitis, see Fig 4 and rhinitis). Several chronic cases are recorded.
Cross-sensitivity (in both directions) has been demonstrated between *P. hysterophorus* and ragweeds (*Ambrosia* spp.) in both American and Indian patients (Towers & Subba Rao, 1992; Sriramarao P & Rao PV, 1993). As *Ambrosia artemisiifolia* is already a major allergenic problem in Europe, the cross-sensitivity with *P. hysterophorus* would amplify the allergies.

Furthermore, Serious impacts upon the health of livestock in *P. hysterophorus*-infested areas have been reported from India (Lakshmi & Srivinas, 2007). Diets containing 10-50% of *P. hysterophorus* can kill cattle and buffaloes within 30 days (Narasimhan *et al.*, 1977a; Narasimhan *et al.*, 1977b; More *et al.*, 1982). Both milk and meat of cattle, buffalo and sheep that have fed upon *P. hysterophorus* may become tainted (Towers & Subba Rao, 1992; Tudor *et al.*, 1982). Cattle may pass the toxic component to their milk (Parson & Cuthbertson, 1992 in Department of Natural Resources, Environment, The Arts and Sport, Government of Northern Territory, 2010).

CONCLUSIONS OF PEST RISK ASSESSMENT

Summarize the major factors that influence the acceptability of the risk from this pest:

P. hysterophorus is a major pest in pastures and crops in its exotic range, and has major detrimental impact on human and animal health through allergies and dermatitis.
If introduced in the area of potential establishment, eradication or containment would be unlikely to be successful due to its high reproductive potential and high spread capacity through human activities.

Estimate the probability of entry:

The probability of entry is considered **likely with a medium uncertainty**.
Many entry pathways are identified and given the past history of introduction around the world of *P. hysterophorus* and its occurrence in Israel, it is likely that the species will enter in further EPPO countries.

Estimate the probability of establishment:

The probability of establishment is **high with a low uncertainty**.
Given access to suitable habitats via its most frequent pathways, it is highly likely that *P. hysterophorus* will establish and spread within the

	Mediterranean sub-region of the EPPO region (it already established and persisted for about 35 years in Israel). Within this sub-region, large areas exist where there is a confluence of suitable climate, soils and land management regimes (including transport infrastructure). It is also likely that *P. hysterophorus* will establish in other areas within the EPPO region (e.g. areas with a cool- and cold-temperate climate) (see Fig. 2).
Estimate the probability of spread:	The rate of spread of the pest is likely to be **high with a medium uncertainty** as the species can spread naturally on a local scale through wind and wild animals, as well as over long distances through human activities as a contaminant of seeds, of grain, on people, in farm yard manure or composts, construction materials, land filling and movement of soil and of vehicles, of fodder, pasture seed, etc.
Estimate the potential economic impact:	The potential economic impact in the area of potential establishment is considered as **major with medium uncertainty**. *P. hysterophorus* would have moderate to major impact on crops and pastures, depending on the intensivity of the production techniques. Environmental impacts are considered to be minor to moderate. Impacts on human and animal health through allergies and dermatitis are considered as major as 50% of the population is reported to be sensitive in case of regular exposure by direct contact. The human health impact is expected to be worse than the one experienced with *Ambrosia artemisiifolia*.
Degree of uncertainty	The overall level of uncertainty is assessed to be medium. The uncertainties are the following: - The current distribution in the EPPO region and in Egypt (the species may be unreported in some EPPO countries); - The effect of allelopathy on other species in the environment and on crops; - The pollen effect on other species fruit production in EPPO countries, such as in olives or grapes; - The densities the species could attain in the EPPO region; - Relationship between *P. hysterophorus* frequency and abundance and health effects; - Uncertainty of behaviour in different soils; - To what extent conventional management methods would manage the species in the EPPO region.
OVERALL CONCLUSIONS	*P. hysterophorus* represents a major threat to plant health as well as to human and animal health. The species is already present in Israel, and its probability of introduction to the remainder of the EPPO region is high, owing to the numerous pathways with which it could enter. The species is likely to establish in the EPPO region, in particular in the Mediterranean basin where pastures and crops would be particularly at risk.

STAGE 3: PEST RISK MANAGEMENT

IDENTIFICATION OF THE PATHWAYS

Pathways studied in the pest risk management	• **Contaminant of used machinery** (<u>Moderately likely, Level of uncertainty: low</u>) • **Contaminant of grain** (<u>Moderately likely, Level of uncertainty: low</u>) • **Contaminant of seeds** (<u>Moderately likely, Level of uncertainty: medium</u>) • **Contaminant of growing media adherent to plants for planting**

(Moderately likely, Level of uncertainty: medium)

- **Contaminant of travellers (tourists, migrants, etc.) and their clothes, shoes and luggage** (Moderately likely, Level of uncertainty: high)

IDENTIFICATION OF POSSIBLE MEASURES

Possible measures for pathways

Contaminant of used machinery (Moderately likely, Level of uncertainty: low)
- Cleaning or disinfection of machinery/vehicles in combination with internal surveillance and/or eradication or containment campaign.

Contaminant of grain (Moderately likely, Level of uncertainty: low)
Measures related to the crop or to places of production:
- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment of the crop, testing of the commodity, internal surveillance and/or eradication or containment campaign.
- Certification scheme
- Import under special licence/permit and specified restrictions (for grain which is aimed to be crushed or transformed).

Contaminant of seeds (Moderately likely, Level of uncertainty: medium)
Measures related to the crop or to places of production:
- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment of the crop, testing of the commodity, internal surveillance and/or eradication or containment campaign.
- Certification scheme for seeds.

Contaminant of growing media adherent to plants for planting (Moderately likely, Level of uncertainty: medium)
Measures related to the crop or to places of production:
- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment, growing in glasshouses and in sterilized soil, internal surveillance and/or eradication or containment campaign.
- Certification scheme for plants for planting
- Removal of the growing medium from plants for planting.

Contaminant of travellers (tourists, migrants, etc.) and their clothes, shoes and luggage (Moderately likely, Level of uncertainty: high)
Systems approach:
- Publicity to enhance public awareness on pest risks
- Internal surveillance and/or eradication or containment campaign.

EVALUATION OF THE MEASURES IDENTIFIED IN RELATION TO THE RISKS PRESENTED BY THE PATHWAYS

The measures identified (pest-free place/site of production) would be likely to have a large impact on the trade from the USA and India.

Degree of uncertainty Uncertainties in the management part are:

- Whether treatment of the crop (for grain and seeds) would effectively manage the species.
- Whether the import under specified restrictions for grain would effectively be respected.

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