



IMPORT RISK ANALYSIS

Pathway - Initiated

FIRST DRAFT

**Importation of Irish Potatoes (*Solanum tuberosum*)
seeds and ware from Canada & Netherland to Jamaica**



Irish potatoes

EXECUTIVE SUMMARY

This risk assessment documents the risks associated with the importation of *Solanum tuberosum* L. (Irish potato) ware and seed from Canada and the Netherlands into Jamaica. Information on organisms associated with potato in Canada and the Netherlands reveals that pests of quarantine importance exist. Without mitigation, these pests could be introduced into Jamaica through importation of commercially produced potato ware and seed. Pests of quarantine importance include: the nematode *Globodera rostochiensis* (golden nematode) and the following pathogens: the bacterium, *Clavibacter michiganensis* subsp. *sepedonicus* (ring rot); two pathogenic fungi, *Spongospora subterranea* (powdery scab) and *Synchytrium endobioticum* (potato wart disease).

The likelihood and consequences of introduction of each pest were assessed individually, and a risk rating estimated for each. The likelihood of introduction value was estimated by assessing the quantity of the commodity to be imported annually and the potential for pest introduction and establishment. The consequence of introduction value was estimated assessing five elements that reflect the biology and ecology of the pests: the host range, climate-host interaction, dispersal potential, economic and environmental impacts. The two values were summed to estimate an overall Pest Risk Potential, which is an estimation of risk in the absence of mitigation.

All pest assessed were given a pest risk potential of **high**. This means that these pests pose unacceptable phytosanitary risk to Jamaica's agriculture. Visual inspection at ports-of-entry is insufficient to safeguard Jamaica's potato industry from these pests. Additional phytosanitary measures are considered necessary to reduce pest risk.

The following are some mitigative measures that may be considered within a systemic approach to reduce the possible risks associated with the above mentioned quarantine pests:

- Requirement for potato to be from pest free areas of production
- Jamaica must stipulate the commercial grade to be imported
- Accept only certified seed potato for crop production
- Shipments of potato must be traceable to place of origin in exporting countries
- Port-of-entry sampling and inspection must be made mandatory

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INTRODUCTION

This import risk assessment was prepared by the Pest Risk Analysis Unit in the Plant Quarantine/Produce Inspection Branch of the Ministry of Agriculture and Fisheries in Jamaica. The assessment examines the risk associated with the importation of *Solanum tuberosum* L. (Irish potato) ware and seed from Canada and the Netherlands into Jamaica. The assessment is qualitative and as such the risks are expressed in terms of low, medium and high. The risk assessment is pathway-initiated in that it is based on the potential pest risks associated with the commodity as it enters Jamaica.

The guidelines for conducting the risk assessment was in accordance to the International Plant Protection Convention (IPPC) as published in the International Standards for Phytosanitary Measures (ISPMs). The methods used to initiate, conduct, and report these assessments are consistent with the guidelines provided by IPPC. The use of biological and phytosanitary terms conforms to the definitions and abbreviations in the ISPMs. The guideline describe three (3) stages of the risk assessment: Stage 1 (initiation), Stage 2 (risk assessment) and Stage 3 (risk management).

Production of potatoes in Canada and the Netherlands

In the absence of official information on potato cultivation in the respective countries, only the elements of production relevant to this risk assessment are outlined here.

Canada

Canada has 171,000 ha (422,541 acres) of land under potato production. In 2002, a total of 4.7 million metric tonnes (10.4 billion lbs) of table potatoes were produced. The main producing province is Prince Edward Island which accounts for 29% of all Canadian grown potatoes. Manitoba is the second largest producer, accounting for 18% of the total, and New Brunswick and Alberta each produce about 15%. British Columbia accounts for less than 3% of national potato production (Ministry of Agriculture, 2003). The Operations directorate of Canada Food Inspection Agency (CFIA) is responsible for seed inspections and issuing certification numbers and phytosanitary certificates (CFIA).

The Netherlands

The Netherlands plant approximately 25 percent of their arable land (160 000 ha) with potato, and have achieved world record average yields level of more than 45 tonnes per hectare. The potato sector is highly mechanized and draws on a list of some 250 approved varieties. Only half of the Netherlands' potato crop is grown directly for food with approximately 20 percent used for seed potatoes, and the remaining 30 percent is processed for starch. About 70 percent of Dutch ware potatoes is exported in the form of fresh tubers and potato products, such as chips and flour. The Netherlands is the world's major supplier of certified seed potatoes, with exports of some

700 000 tonnes a year (International year of potato, 2008). The Plant Protection Service (PD) of the Dutch Ministry of Agriculture, Nature and Food quality plays a role in the monitoring of seed potatoes in association with NAK, the Dutch general inspection service for agricultural seed and seed potatoes (The Inspection of Dutch Seed Potatoes, 2005).

Stage 1: INITIATION

1.1 Commodity to be imported

Irish potato (*Solanum tuberosum*) seeds and ware.

1.2 Country of origin

The risk analysis is being done for potatoes being imported from Canada and the Netherlands.

1.3 Pest Risk Analysis area (Importing Country)

Jamaica.

1.4 Intentional Use of Commodity

Ware and seed potatoes are imported into Jamaica for consumption and planting respectively.

1.5 Previous PRA done/Status

A previous PRA was done on Irish potato from Argentina. The PRA is currently before the PRA review committee; however no consideration was included for the pests being assessed in this risk analysis.

1.6 Pest Interceptions

Pest interceptions on potato from the Netherlands and Canada are summarized in table 1

Table 1: Results from diagnostics test conducted on imported potato seed samples

Source/Country of origin	Variety	Pathogen/Disease found present	Appearance of tubers
Holland/ the Netherlands	Spunta	✓ Bacterial wilt (tuber brown rot) (<i>Ralstonia solanacearum</i>) (bacteria)	Healthy (asymptomatic)
		✓ Fusarium wilt	

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		<p>(tuber dry rot) <i>(Fusarium oxysporum)</i>)(fungus) ✓ Skin spot <i>(Polyscytalum pustulans (fungus))</i></p>	
Canada	Spunta	<p>✓ Bacterial wilt (tuber brown rot) <i>(Ralstonia solanacearum)</i> (bacteria) ✓ Fusarium wilt (tuber dry rot) <i>Fusarium oxysporum</i> (fungus) ✓ Black dot <i>(Colletorichum coccodes)</i> (fungus)</p>	Most seed samples appeared healthy but few manifested tuber rot symptoms

(extracted from a report done by the Research and Development Division, Ministry of Agriculture, Jamaica)

STAGE 2: PEST RISK ASSESSMENT

1.0 Pest Categorization – Identification of Quarantine Pests

The risk assessment was done with the aim to revise Jamaica's phytosanitary measure regarding the importation of ware and seed potatoes. The pests listed in the table below are those of phytosanitary importance to Jamaica and was listed on the country's additional declaration list for potatoes entering Jamaica.

Table 2: Pests of significance to Jamaica on Irish potato imports from Canada and the Netherlands.

Pests	Common Name	Geographical distribution ¹	Present in Importing Country (Jamaica)	Quarantine Status in Jamaica ²	Present on Pathway	Potential Economic Impact	References
BACTERIA							
<i>Clavibacter michiganensis</i> subsp <i>sepedonicus</i>	Ring rot of potato	Canada, Netherland	Not present	QP ³	Tubers	High	CABI ⁴ , MOA&F ⁵
FUNGI							
<i>Synchytrium endobioticum</i>	Potato wart disease	Canada, Netherland	Not present	QP ³	Tubers	High	CABI ⁴ , EPPO
<i>Spongospora subterranea</i>	Powdery scab of potato		Not present	QP ³		High	
NEMATODE							
<i>Globodera rostochiensis</i>	Golden nematode	Canada, Netherland	Not present	QP ³	Tuber, soil	High	APHIS, CABI ⁴

¹ Distribution status quoted in the table is in relation to the major exporting countries of potato to Jamaica.

² Quarantine status was justified on the basis that the pest is absent from the importing country (Jamaica) and has the potential to cause economic impact as defined in ISPM 5

³ QP- Quarantine Pest

⁴ CABI- Centre for Agriculture and Biosciences International

⁵ Ministry of Agriculture & Fisheries, Jamaica

2.0 RISK ASSESSMENT

The risk assessment was done in accordance with International Plant Protection Convention (IPPC) and the International Standards for Phytosanitary Measures (ISPMs) including ISPM 2 and ISPM 11. The import risk assessment consists of two main components, the probability of a pest being introduced and the consequence of the introduction to the importing country. The probability of introduction evaluates the entry, establishment and dispersal of the pest while the consequences measure the economical and environmental impact to the importing country. Each risk is then assigned a qualitative value and a risk rating value (see table 3). The risk values are combined to give an overall estimate of the risk.

Table 3: showing risk rating and corresponding risk value

Risk rating	Rating value
High	3
Medium	2
Low	1

2.1 THE LIKELIHOOD OF INTRODUCTION

The likelihood of introduction is a function of the quantity of the commodity to be imported as well as the opportunity provided for the quarantine pests to survive pre and post harvest handling. The pest's opportunity is defined by six criteria that consider the potential for the pest survival along the pathway (PPQ, 2000- Table 6). These include the pest's opportunity to survive pre- and postharvest treatment and shipment, the possibility of avoiding detection at port of entry and the potential to find suitable host.

2.1.1 *Quantity Imported Annually*

The rating for the quantity imported annually is based on the amount of commodity expected to be imported. For qualitative import risk assessments, the amount of the commodity imported is estimated in units of standard 40-foot long shipping containers. The rating assigned is as follows:

Table 4: showing the risk rating and value assigned to quantity of shipping containers imported annually.

Quantity (containers/year)	Rating	Rating value
> 10	Low	1
10-100	Medium	2
<100	High	3

Approximately 98% of the potato produced in Jamaica is propagated from imported seed potatoes. Jamaica imports on average 760 tons of seed potatoes which amounts to 22 forty-foot shipping containers annually. Import of ware potato increases this amount. The probability of pest entering as a direct result of the quantity of the commodity being imported is therefore **high (3)**.

2.1.2 Survive Pre-harvest Treatment

The cultivation practices, soil types and topography of land employed during crop production are used to determine the survival potential of a pest during the crop growing season.

a. Clavibacter michiganensis subsp. sepedonicus - Ring rot

Control of pathogens in potato production generally involves exclusion, sensitive detection methods and sanitation (USDA, 2003). Several pre-harvest practices are employed by Canada and Netherland to exclude pathogens from potato cultivation. These include:

- the certification of seed potatoes by the Canada Food and Inspection Agency (CFIA) and NAK in Canada and Netherland respectively.
- the use of resistant cultivars.
- discouraging the use of irrigation
- periodical inspection and sample testing

Despite the various cultivation practices, tubers are known to be infected with ring rot primarily because it is not always possible to detect the bacterial infection in the field or in tuber due to its latent nature. It is also impossible to predict how long it will take for a latent infection to become visible (The Inspection of Dutch Seed Potatoes, 2005). Ring rot may infect tubers directly or indirectly through contaminated soil (USDA, 2003), irrigation water, contact with infected tuber or with any contaminated tool or equipment and via the feeding of chewing insects such as the Colorado potato beetle. Ring rot is however considered a quarantine bacterial disease in both Canada and the Netherland, consequently resulting in seed potatoes being intensively tested for its presence and seed certification being mandatory (NAK and CFIA). Despite these measures, the survival potential of the bacteria in potato production areas in these countries remains relatively high primarily due to its highly infectious nature, ability to spread through latent infected tuber, overwintering capabilities, and the presence and wide distribution of the Colorado potato beetle (acting as a vector) in Canada and Netherland respectively (CABI, 2006). The detection of the bacteria in seed potatoes imported from Netherland into Jamaica does confirm the pathogen ability to survive pre-harvest practices in the exporting country. – **high (3)**

b. Globodera rostochiensis – Golden nematode

Golden nematode is mainly control through quarantine regulations regarding movement of potentially infested soil, equipment and other materials used in handling potatoes. Survey and soil sampling is also important. Only the province of Newfoundland in Canada is currently infested with the nematode and stringent regulations are in place to prevent spread (CFIA), the risk is therefore **low (1)**. The mitigative measures in Netherland are unknown therefore the uncertainty is **high (3)**. An average rating of **medium (2)** is then assigned.

c. Synchytrium endobioticum- Potato wart disease

The pre-harvest manipulations used in the control of the disease include, the use of resistant cultivars, abandoning of infected potato production area, as well as chemical control (though not recommended). If these pre-harvest practices are upheld and supplemented with statutory measures, the existence of the pathogen on potatoes will be **low (1)**.

d. Spongospora subterranea - Powdery scab

According to CABI, 2006, powdery scab is present in several provinces in Canada and the Netherlands, suggesting that the cultivation practices, topography and soil type in these countries are conducive for the disease. Equally Jamaica's cultivation practices and soil types (the pathogen is prevalent in all soil types) can allow the pathogen to persist once established. Distribution of infested soil or infected tubers can result in dissemination of the fungus. Soil fumigation has been used; however it only reduces the infestation but doesn't eliminate spores. Stringent cultural practices such as long crop rotation (3-10years) can help to reduce soil population but is rarely practical (Johnson). The risk of survival is considered **high (3)**, especially because of the pathogen ability to survive in the soil for many years.

2.1.3 Survive Post-harvest Treatment

This refers to any manipulation, handling or specific phytosanitary treatment to which the commodity is subjected and will have an effect on the pest; these may include culling, washing, chemical treatment, cold storage etc.

a. Clavibacter michiganensis subsp. *sepedonicus* - Ring rot

Cutting, grading and handling of seed tubers are all measures employed in the post harvest management of potatoes, but are also ideal means of spreading ring rot within and between potato stocks (DEFRA). Tools and machinery used in these practices can also serve as reservoir for the ring rot bacterium. The bacterium can survive for at least a month on machinery and much longer if the machinery dries rapidly and is kept under dry conditions after contamination. Sharing equipment and machinery that is used to harvest, grade or process seed and ware potatoes therefore poses a very high risk of cross-infection between different growers (DEFRA).

Ring rot can also survive and remain infectious for several years on potato bags, boxes, store walls and other surfaces that have been contaminated by rotting ooze (Defra) even if exposed to temperatures well below zero (Rowe et. al).

Though grading, lot inspection (purely physiological) and mandatory disinfection of tools and equipment use for harvest or in storage of potatoes are employed in Netherland and Canada, these methods have not proven to eliminate the risk of infested potatoes being exported. In fact samples of imported potatoes from Netherland tested positive for ring rot by the Jamaica Plant Pathology Unit (Ministry of Agriculture) despite the post harvest inspections and management practices reported by NAK (The Inspection of Dutch Seed Potatoes, 2005). Additionally, potatoes stored for extended periods of time at cool temperatures as is the practice in Canada and Netherland (NAK and CFIA) only enhance the survival capabilities of the bacterium (Rowe et. al). The post harvest survival potential of the bacterium is therefore **high(3)**.

b. Globodera rostochiensis – Golden nematode

The only postharvest treatment currently permitted for the control of nematodes in potatoes is methyl bromide (USDA, 2003). Despite the existence of various mitigative practices, the specific phytosanitary measure that may be applied in Netherland and Canada and their efficacy are currently unknown. Because of this uncertainty and the possibility of low density cyst going unnoticed, the probability is estimated as **high (3)**.

c. Synchytrium endobioticum- Potato wart disease

Control of pathogens in potato production generally involves exclusion of infected potatoes, sensitive detection methods and sanitation (USDA, 2003). Additionally for potato wart disease, checking for the presence of soil is critical. However with it being impractical to remove all soil from the tuber (USDA, 2003), coupled with the possibility of warts developing in storage (EPPO, 1997), the risk of surviving post harvest treatment is **medium (2)**.

d. Spongospora subterranea - Powdery scab

Infected potato tubers can pass on spores to non-infected tubers in storage. Spores are usually easily dislodged and become airborne; the spores on the surface of tubers can then move into soil at planting. Infected tubers are also predisposed to other maladies such as *Fusarium* rot, bacterial soft rot and other opportunistic invaders. Removal of infected tubers will not eliminate the pathogen as the spores will have been spread neither washing of the tubers as this will provide moist condition needed for the pathogen to proliferate. The risk is therefore **high (3)**.

2.1.4 Survive Shipment Conditions

This element estimates the pest likelihood of surviving the standard transit temperature and relative humidity for potato. Using the ‘Proper environment for potato storage,’ published by the University of California in cooperation with the USDA, the recommended temperature for fresh market and seed potatoes are 4.5 and 3.5 to 4.5 degree celsius respectively (Voss et. al).

a. *Clavibacter michiganensis* subsp. *sepedonicus* - Ring rot

The conditions used in storage are similar to those used in shipping to prevent changes in the tuber's physiological condition due to spoilage or sprouting. Appropriate temperature and relative humidity, adequate ventilation and treatment with sprouting inhibitor are employed during storage of potatoes. These conditions do not however inhibit the survival of the bacterium; in fact, the ring rot bacterium is capable of surviving at temperatures well below freezing (Rowe et al.). The same article also reports that the bacterium survival is longest in cool dry temperatures. As previously mentioned, the positive test obtained on samples of potatoes imported from Netherland is evident that the bacterium can survive shipping conditions. This probability is therefore **high (3)**.

b. *Globodera rostochiensis* – Golden nematode

Eggs of golden nematode can remain dormant within the dead female's body (the cyst) until the proper stimulus to hatch is received. Considering the egg has a resting stage, the likelihood of surviving shipment conditions is **high (3)**.

c. *Synchytrium endobioticum*- Potato wart disease

The pathogen has resistant, thick walled winter sporangia, which can remain viable for 30 years (EPPO, 1997). Potatoes are shipped at cool temperatures (3.5 to 4.5°C) which is similar to temperatures experience during winter, it is therefore expected that the fungus will survive. The risk rating is therefore **high (3)**.

d. *Spongospora subterranea* - Powdery scab

The pathogen has a resistant resting stage, which will allow the pathogen to withstand shipment conditions until suitable conditions and host for disease development can occur. The risk is therefore **high (3)**.

2.1.5 Detection at Port- of- Entry

In assessing the risk that these potato pests will not be detected at a port of entry, consideration is given to their degree of concealment. Pathogens are microscopic and cannot be detected because tubers may appear symptomless. Latent infections are undetected by visual inspection and reliable detection must be done by laboratory assays, which may take unacceptably long time even if an infrastructure exist to sample and assay the plant material. Some assays may take

weeks; this is incompatible with the pace of port decisions that are often made within days (USDA, 2003).

a. Clavibacter michiganensis subsp. *sepedonicus* - Ring rot

Ring rot derives its name from a characteristic breakdown of the vascular ring within the tuber. This often appears as a creamy-yellow to light-brown, cheesy rot. The symptom is most frequently observed when a diseased tuber is cut crosswise at the stem end. In severe cases, the vascular ring may be separated, and a creamy or cheesy exudate can be forced out from this tissue when the tuber is squeezed. On the outer surface, severely diseased tubers may show slightly sunken, dry, cracked areas. Infected tubers are often invaded by secondary decay organisms which may lead to complete breakdown. Symptoms of ring rot in the vascular tissue of infected tubers are often less obvious than described above, appearing as only a broken, sporadically appearing dark line, or as a continuous, yellowish discoloration. Because of this, laboratory tests are recommended to confirm a diagnosis of ring rot. The symptoms of ring rot are variable and are sometimes masked by other diseases, only laboratory testing can confirm its presence, it can therefore escape detection at port of entry therefore making the probability **medium (2)**.

b. Globodera rostochiensis – Golden nematode

Potatoes infested with this nematode tends to have reduced size, however the symptoms of golden nematode can have many other causes and cannot be taken as a proof of nematode presence (EPPO, 1997). If the cysts are present at low densities, no distinct symptoms are present and the symptoms that appear at high densities are of limited diagnostic value. It is difficult and may be impractical to produce field-grown potatoes totally free of contaminants such as soil, and reliable detection can only be done by laboratory testing, which may take unacceptably long time for port-of-entry detection (USDA, 2003). For these reasons the rating is **high (3)**.

c. Synchytrium endobioticum- Potato wart disease

Symptoms usually appear on tubers, with infected tuber eyes developing into characteristic warty, cauliflower-like swellings. If exposed to light, the warts turn green. Tubers may bear more than one warty outgrowth and in some cases the whole tuber can be affected. When infected early, tubers can become so distorted and spongy that they are almost unrecognizable. Symptoms of powdery scab and bud proliferation can be similar to those of wart disease and are frequently mistaken for it (DEFRA). Positive confirmation of wart disease requires a scientific laboratory diagnosis. The risk rating is therefore **medium (2)**.

d. Spongospora subterranea - Powdery scab

Pathogens are generally difficult to detect visually and expressed symptoms may be mistaken. The symptoms on tubers infected by powdery scab loosely resemble those of common scab and wart disease (DEFRA and Johnson) as such laboratory testing is required for confirmation. The risk is therefore **high (3)**.

2.1.6 Potential to find suitable host

This considers the geographical location of likely markets and the proportion of the commodity that is likely to move to locations suitable for pest survival. Even if infested commodity enters the country, not all final destinations will have suitable climatic conditions for pest survival.

a. Clavibacter michiganensis subsp. *sepedonicus* - Ring rot

Imported potato seeds and ware are sold throughout Jamaica. Latently infected potatoes may present a risk if they come into contact with potential host (primarily potato). The ware and seeds may be stored and handled together and in effect increase spread of the pathogen in a lot of potatoes. Seed potatoes used for planting in Jamaica are predominantly from imports. The rating is **high (3)**.

b. Globodera rostochiensis – Golden nematode

The most important host of the golden nematode is potato. According to the EPPO quarantine pest datasheet, seed potato is the main means by which the cyst is introduced into new areas. With Jamaica's heavy reliance on imported seed potato and its island wide distribution, it is expected that the nematode cyst once introduced will find suitable host. The rating is therefore **high(3)**.

c. Synchytrium endobioticum- Potato wart disease

The main means of spread is in infected seed potatoes and by contaminated soil. With Jamaica heavy reliance on imported seed potato and its island wide distribution coupled with the tolerance of 1% of soil on potato imports, it is expected that the potato wart once introduced will find suitable host. The rating is therefore **high (3)**.

d. Spongospora subterranea - Powdery scab

The wide distribution of seed potato, which is a vector for the pathogen, across the island increases the likelihood of the pest potential to find suitable host coupled with the high dispersal potential. The risk is therefore **high (3)**.

2.1.7 Cumulative Summary: Likelihood of Introduction of the Pests

Table 5: Cumulative Risk Summary for the Likelihood of Introduction of the pests from Canada and Netherland

Pest	Quantity Imported Annually	Survive pre-harvest treatment	Survive post-harvest treatment	Survive Shipment	Detection at port-of-entry	Potential to move to suitable host	Cumulative Risk Rating
Bacteria							
<i>Clavibacter michiganensis</i> subsp. <i>sepedonicus</i>	3	3	3	3	2	3	17
Fungi							
<i>Synchytrium endobioticum</i>	3	1	2	3	2	3	14
<i>Spongospora subterranea</i>	3	3	3	3	3	3	18
Nematode							
<i>Globodera rostochiensis</i>	3	2	3	3	3	3	17

2.2 CONSEQUENCES OF INTRODUCTION OF QUARANTINE PESTS

The consequences of introduction assesses the undesirable outcomes being considered resulting from the introduction of quarantine pests. This element is rated using five risk criteria: host range, climate-host interaction, dispersal potential, economic and the environmental impact. The biology/ecology of the pests is reflected in these criteria. The criteria are assigned a risk rating and value of low (1), medium (2), and high (3); a cumulative risk rating is calculated by summing all risk criteria values.

2.2.1 *Host Range*

The risk is simply rated on the host range of each pest. A low risk rating means that the pest only attacks a single species or multiple species within a single genus; a medium rating is assigned when the pest attacks multiple species in a single family. However the risk rating is high when multiple species from multiple families are attacked.

a. *Clavibacter michiganensis* subsp. *sepedonicus* - Ring rot

The natural infection causing disease has been found on potatoes only. Sugarbeet has been described as a natural symptomless host and the bacterium has also been found in sugarbeet seeds. In inoculation tests many members of the solanaceae, including tomatoes and aubergines, were found to be susceptible (CABI, 2006). The rating is **medium (2)**.

b. *Globodera rostochiensis* – Golden nematode

Potatoes are by far the most important host crop of the golden nematode, tomatoes and aubergines are also attacked. Other *Solanum* spp and their hybrid can also act as hosts (CABI, 2006). The risk rating is therefore **medium (2)**.

c. *Synchytrium endobioticum*- Potato wart disease

Potato is the only cultivated host, but wild *Solanum* spp. was also reported to be infected in Mexico (CABI, 2006). The rating is therefore **low (1)**.

d. *Spongospora subterranea* - Powdery scab

The pathogen is known to affect members of the solanaceae family with potatoes and tomatoes being the main hosts(CABI, 2006). Tomato is however rarely affected because this cool temperature pathogen is not well adapted to the warm to hot temperature conditions in which tomatoes are usually grown. The rating is therefore **medium (2)**.

2.2.2 *Climate-Host Interaction*

Pests are expected to behave as they do in their native areas when introduced into new areas provided that the hosts plants and climate are similar. The ecological zonation and the

interactions of the pests with their biotic and abiotic environments are considered. Estimates are based on availability of both host material and suitable climate conditions.

a. *Clavibacter michiganensis* subsp. *sepedonicus* - Ring rot

C. michiganensis subsp. *sepedonicus* has a relatively low temperature optimum for growth (21°C) and is mainly confined to cooler areas of the world. In the southern part of the EPPO region, climatic conditions would probably not favour ring rot except, perhaps, in mountainous areas (EPPO, 1997). The traditional potato production areas in Jamaica are in the cooler parts of the country, which can experience minimum temperatures as low as 14.1°C (Met Services, Jamaica). The risk is therefore **medium (2)**.

b. *Globodera rostochiensis* – Golden nematode

The nematode is currently distributed in temperate zones down to sea levels and in tropics at higher altitudes where the potato crop is cultivated (EPPO, 1997). The later distribution description correlates with the cultivation practices of the potato crop in Jamaica and therefore the risk rating is **high (3)**.

c. *Synchytrium endobioticum*- Potato wart disease

The fungus can survive in all season. *S. endobioticum* sporangia persist so long in soil that it has hardly been possible to evaluate any differences in survival potential under differing soil and climatic conditions and in the presence of other plants (EPPO 1997). It is however reported that the pathogen favours cool, wet soil (DEFRA). On the whole, in Mediterranean countries with warm, light, well drained soils, the disease is unlikely to cause serious direct losses, but its introduction and persistence could still be a problem (EPPO, 1997). The climate host interaction is **high (3)**.

d. *Spongospora subterranea* - Powdery scab

The pathogen flourishes in soil temperatures less than 20°C. The optimal soil infection temperature is between 12-18°C (Johnson). The traditional potato production areas in Jamaica are in the cooler parts of the country, which can experience minimum temperatures as low as 14.1°C (Met Services, Jamaica). Despite the environmental conditions being conducive, the host must be present and at a susceptible stage for the disease to occur (Johnson). The risk is therefore **medium (2)**.

2.2.3 *Dispersal Potential*

Pests may disperse after introduction into new areas. The dispersal potential indicates how rapidly and widely the pest's economic and environmental impact may be expressed within the importing country or region. The dispersal potential is evaluated based on the pest's reproductive potential, inherent mobility, and dispersal ability. Factors for rating the dispersal potential include: the presence of multiple generations per year or growing season, the relative number of offspring or propagules per generation, any inherent capabilities for rapid movement, the presence of natural barriers or enemies, and dissemination enhanced by wind, water, vectors, or human assistance.

a. *Clavibacter michiganensis* subsp. *sepedonicus* - Ring rot

C. michiganensis subsp. *sepedonicus* is a short, non-motile, gram-positive rod. Its means of spread are through the planting of infected seed potatoes and contamination of containers, equipment and premises. When seed potatoes are cut before planting the cutting knife is an important dispersal unit: after cutting an infected tuber, 20-30 healthy tubers may be infected. Planters and graders which have been contaminated by bacteria from a few badly diseased potatoes are also a potent infection source. Spread in the field from plant to plant is usually very low, but there is experimental evidence that some insects, including Colorado beetle, by way of chewing can spread the bacterium (EPPO, 1997). The bacterium is not known to survive in soil in the absence of potato debris, but can survive from season to season in volunteer potato plants (Rowe et. al). The risk of dispersal is therefore linked to sanitation and handling of the potatoes and equipment at ports of entry as well as distribution sites across the country. This risk may be further increase with the island wide distribution of the commodity throughout the relatively small island as well as the farming culture within Jamaica, where there are few distributors of planting materials and sharing of equipment by farmers. This disease is particularly serious because it has the potential to spread quickly throughout a farm and may lead to severe losses if left unchecked (Rowe et. al), the risk rating is therefore **high (3)**.

b. *Globodera rostochiensis* – Golden nematode

Golden nematodes have no natural means of dispersal, they can only move short distances as a result of attraction to roots in soil by juveniles. However the nematodes are known to spread to new areas as cysts on seed potatoes, nursery stock, soil, flower bud and ware potatoes. The spread via ware potatoes poses a risk if these potatoes are planted or accompanying soil is not disposed of carefully (CABI, 2006). With the importation of seeds and ware potatoes from countries with known distribution of the nematode (in particular some provinces in Canada and the Netherlands) and the standard 1% of soil accepted, the risk in the nematode dispersal potential once cysts are present on potatoes or in soil is **high (3)**.

c. *Synchytrium endobioticum*- Potato wart disease

Sporangia of *S. endobioticum* contains 200 to 300 motile zoospores, which when release uses their flagellum to enable them to move in soil water to reach living host. Once host cells are penetrated, reproduction occurs quickly with new zoospores being discharged and infecting new cells. Apart from these limited means of natural spread, it is liable to be carried in infected potato tubers or in soil alone or accompanying plants, from land on which potato warts occur in the past (EPPO, 1997). Other potential sources include: soil attached to farm machinery or tools; soil from vegetable processing plants; and manure from animals fed on infected tubers.

With the high levels of seed potato importation by Jamaica , the 1% soil allowed and the sharing of equipment as a part of Jamaica’s farming culture, the risk is **high (3)**.

d. Spongospora subterranea - Powdery scab

The pathogen can be spread by its motile zoospores in water flow in or above the soil. Water flow is predominantly caused by irrigation and rainfall. Spores can also be spread by the use of seed potato tubers in production (CABI, 2006). The dispersal potential resulting from the water flow channels and seed potato usage in production renders the risk rating **high (3)**.

2.2.4 Economic Impact

Introduced quarantine pests has the potential to cause direct and indirect economic impacts such as reduced yield, reduced commodity value, loss of foreign or domestic markets, and non-crop impacts. Factors considered during the risk rating included whether the pest would affect yield or commodity quality, cause plant mortality, act as a disease vector, increase costs of production including pest control costs, lower market prices, affect market availability, increase research or extension costs, or reduce recreational land use or aesthetic value.

a. Clavibacter michiganensis subsp. *sepedonicus* - Ring rot

Economic losses are due to wilt and tuber rotting in the field and in store. Damage is caused by destruction of vascular tissues and subsequent wilting and dying of plants and secondary rotting of tubers. Indirectly, expenses of disinfecting machinery, stores, and prohibition of potato cultivation may increase economic loss. Crop losses have been mainly reported from North America with up to 50% and from Russia with 15-30% of plants infected and up to 47% crop loss (EPPO, 1997). Once established the cost of control is considered to be high as the disease require vigilance from all sectors of the industry, from growers through to consumers. The risk rating is therefore **high (3)**.

b. Globodera rostochiensis – Golden nematode

The golden nematode is one of the world’s most damaging potato pests (APHIS, 2008). The amount of damage, particularly in relation to the weight of tubers produced, is closely related to the number of nematodes eggs per unit of soil. It has been estimated that approximately 2 tonnes

per hectare of potatoes are lost for every 20 eggs per gram of soil. Up to 80% of the crop can be lost when nematode populations are raised to very high levels by repeated cultivation (EPPO, 1997). The economic impact to Jamaica if established is therefore **high (3)**.

c. Synchytrium endobioticum- Potato wart disease

Potato wart disease is so important that, for some 65 years, quarantine and domestic legislations have been in force throughout the world to prevent its spread. Once *S. endobioticum* has been introduced into a field, the whole crop may be rendered unmarketable and moreover the fungus is so persistent that potatoes cannot be grown again safely for many years, nor can the land be used for any plants intended for export (EPPO, 1997). The risk rating is **high (3)**.

d. Spongospora subterranea - Powdery scab

Economic losses are usually not significant when potatoes are marketed immediately without washing because tubers are generally only affected on the surface which is most often peeled off. At worst, they become unsightly. Worldwide, surface lesion areas of 30-50% are not uncommon when crops are subjected to heavy rainfall and low temperatures (CABI, 2006). Though on its own, the economical impact is minimal, the pathogen pre-disposes the potatoes to *Fusarium* dry rot, bacterial soft rot and is a vector for potato mop-top virus, which a highly destructive disease. The economic impact indirectly ranges from 30-73% (CABI, 2006) and is therefore **high (3)**.

2.2.5 Environmental Impact

The potential assessment of every pest to cause environmental damage is considered by evaluating the following factors, ecological disruptions, biodiversity threat or reduction, and chemical or biological control plans adoption. The environmental impact reflects the potential for these quarantine pests to adversely affect native species outside the potato agroecosystem (PPQ).

a. Clavibacter michiganensis subsp. *sepedonicus* - Ring rot

The bacterium is not expected to stimulate the initiation of chemical or biological control programmes, since currently none exist (EPPO, 1997). The host range of ring rot is largely limited to potato, though sugar beet is a symptomless host. Laboratory testing has extended the bacterium range of host infestation to the family Solanaceae to include tomatoes and aubergines. Based on its limited natural host range and no existing chemical and biological control methods, the environmental impact risk is **low (1)**.

b. Globodera rostochiensis – Golden nematode

Control of golden nematode is traditionally through crop rotation. More recently, crop rotation has been supplemented by use of resistant potato cultivars and nematicides (EPPO, 1997). Consequently the potential introduction of the chemical measures to control the nematodes stands to negatively impact on the environment. This would render the environmental impact to be **high (3)**.

c. Synchytrium endobioticum- Potato wart disease

Chemical control of wart is extremely difficult and may harm beneficial soil organisms consequently resistant varieties of potato are bred to control the disease. Alternatively, infested land is taken out of production because of the persistent nature of the fungus (Murphy). The environmental impact, if chemical control were to be introduced is adverse and the risk rating is therefore **high (3)**.

d. Spongospora subterranea - Powdery scab

The control of powdery scab, if Jamaica was to be infected, would require the adoption of chemical and cultural methods. These would include but not limited to, site selection, long crop rotation periods, avoid irrigation and chemical treatment of soil. Consequently the environmental impact would be **medium (2)** if the ecology is not impacted; this is dependent on the type of chemical use to treat soil (CABI, 2006).

2.2.6 Cumulative Risk Summary: Consequences of Introduction

Table 6: Cumulative Risk Summary for the Consequences of Introduction of the pests from Canada and Netherland

Pest	Host Range	Climate/Host Interaction	Dispersal potential	Economic Impact	Environmental Impact	Cumulative Risk Rating
Bacteria						
<i>Clavibacter michiganensis</i> subsp. <i>sepedonicus</i>	2	2	3	3	1	11
Fungi						
<i>Synchytrium endobioticum</i>	1	3	3	3	3	13
<i>Spongospora subterranea</i>	2	2	3	3	2	12
Nematode						
<i>Globodera rostochiensis</i>	2	3	3	3	3	14

Conclusion: Pest Risk Potential and Pests Requiring Phytosanitary Measures

To estimate the pest risk potential for each pest, the cumulative risk rating for the consequences of introduction and likelihood of introduction is summed. The risk potential ratings are assigned as follows:

- Low: 11-18 points
- Medium: 19-26 points
- High: 27-33 points

Table 7: The Overall Pest Risk Potential Rating

Pests	Likelihood of Introduction	Consequences of Introduction	Pest Risk Potential
Bacteria			
<i>Clavibacter michiganensis</i> subsp. <i>sepedonicus</i>	17	11	28
Fungi			
<i>Synchytrium endobioticum</i>	14	13	27
<i>Spongospora subterranea</i>	18	12	30
Nematode			
<i>Globodera rostochiensis</i>	17	14	31

Pest with unmitigated Pest Risk Potential of ‘low’ do not require specific mitigative measures beyond normal port of entry inspection, whereas a value within the ‘medium’ range indicates that specific phytosanitary measures may be necessary. The PPQ guidelines state that a ‘high’ Pest Risk Potential means that specific phytosanitary measures are strongly recommended and that port of entry inspection is not considered sufficient to provide phytosanitary security.

Stage 3: RISK MITIGATION OPTIONS

For each organism classified as having a high pest risk potential, risk management /mitigation options are proposed, which identifies the options available for managing the risk. In addition to the options presented, feedback is sought from stakeholders on these options through consultations. The risk analysis is then finalized following consultations and will present options, refined if appropriate, for the phytosanitary measures to be considered. Measures are recommended to the Chief Plant Quarantine Officer for decision once the measures are deemed to be appropriate.

3.1 Recommendations

3.1.1 Pre-harvest Management Options

- i. **Use of pest resistant varieties:** The use of resistant varieties is a common and effective component in reducing pest risk. The use of resistant potato varieties, for example, was successful in the complete control of golden nematode (USDA, 2003).
- ii. **Chemical spray programme:** Pre-harvest chemical sprays may be used to control pests within production fields, for example, the use of nematicides to control the golden nematode.
- iii. **Seed handling:** Before handling seed tubers, all containers, tools, knives and mechanical cutters, planters, and other equipment should be thoroughly washed with a detergent solution, rinsed, and then sanitized with a disinfectant. When cutting seed tubers, the cutting tool should be periodically washed and sanitized. It is essential that this be done before cutting seed tubers from a different source. To be effective, disinfectants must be present for a minimum of 10 minutes (preferably 20–30 minutes) on any surface being treated (Rowe et. al).
- iv. **Crop rotation:** Certain potato diseases can survive from season to season in the field. Depending on the type of pathogen, it may survive in the resting form either in the soil or in potato plant debris, or in a living form in surviving potato tubers. On occasion, diseased tubers survive the winter and grow the following spring as diseased volunteer plants. These volunteer potatoes are a source of contamination for the current season crops. A three to four year rotation to minimize soil disease problems is recommended (Western Potato Council, 2003).
- v. **Control of Insects:** Sucking and chewing insects may transmit many diseases. For example the ring rot disease was found to be transmitted by the Colorado potato beetle, leafhoppers and aphids (EPPO, 1997). The control of these insects and the rouging of

infected plants as early as possible may prevent spread of diseases in the field (Western Potato Council, 2003).

- vi. **Irrigation practices and soil type:** A well drained soil is recommended for planting of potatoes as this make conditions less favourable to disease infection (Johnson). Over irrigation and a poorly drained soil increases the susceptibility to diseases such as powdery scab. The type of irrigation system may also aid in the transmission of some diseases (Western Potato Council, 2003).
- vii. **Pre-harvest Inspection:** The relevant officers and inspectors from the importing country should inspect and verify the cleaning and disinfecting of equipment and storage used in potato production. Laboratory testing should be done periodically. Quarantine restrictions may be used to limit spread of diseases detected.

3.1.2 Post-harvest Management Options

- i. **Sanitization of equipment and material:** All machinery, transport and storage surfaces that the seed will contact should be cleaned and disinfected prior to receiving new potato. Sanitation consists of cleaning and disinfecting all equipment, storage, tools and pallet boxes that contact the seed and ware potatoes. Since most disinfectants are inactivated by soil and plant debris, it is essential that this material be removed by thoroughly cleaning the equipment and storage with a pressure washer or steam cleaner before the disinfectant is applied (Western Potato Council, 2003).
- ii. **Disposal of infected tuber:** All infected tuber should be discarded away from production site (Rowe et. al).
- iii. **Bruise prevention:** Potato tubers bruise easily during harvest in certain conditions. Soil and tuber conditions, as well as harvester operation are likely to influence bruising.
- iv. **Seed storage:** Potato should be stored at (3-5°C) with 95% RH. The condition of the potato piles should be checked periodically to ensure temperature and relative humidity are maintained. This is important to minimize disease development. Access to the storage should be restricted to reduce potential for introducing diseases (Western Potato Council, 2003).
- v. **Seed grading:** the class and variety of potatoes must be kept separate through harvesting, grading and storage. Grading must be done according to class, variety and disease tolerance. The class of potatoes must clearly identifiable and labelled.

3.1.3 Phytosanitary Measures

- i. **Pest free areas:** Jamaica must require from importing countries that potatoes be produced in a pest free area. This will ensure that the specific pests of concern are removed from the pathway. The pest free areas should be approved by the Plant Quarantine / Produce Inspection Branch. This measure is highly effective where it is feasible to implement.
- ii. **Stipulated commercial grade for potatoes:** This ensures a certain level of quality and cleanliness which results from commercial handling. This is a significant measure for pests that affect quality or associated with contaminants (eg. soil). Jamaica should therefore make request for a certain grade of potato that reflects the acceptable tolerance level of the country.
- iii. **Accept only certified seed potato for crop production:** This measure is highly effective in mitigating pest risk because it ensures the absence of specific pests, particularly pathogens, or a defined low prevalence of pests at planting. The main components of seed potato certification include: sampling and testing of production areas to ensure freedom from nematodes; approval of land and seed to be multiplied; inspection of crops for variety purity and crop health; sampling and testing for presence of viruses; formal classification of seed crops; inspection of tuber samples; and sealing and labelling of certified seed. Potatoes to be imported from Canada and the Netherlands should be sourced from an officially recognized seed certification system.
- iv. **Shipments traceable to place of origin in importing countries:** A requirement that potatoes be packed in containers with identification labels indicating the place of origin, variety and grade is necessary to ensure traceability to each production site.
- v. **Port-of-entry sampling and inspection:** Sampling of potato consignments at port-of-entry in Jamaica should combine visual inspection and laboratory testing. Visual inspection is useful to verify that certain phytosanitary certification requirements have been met and consignment is generally free of contaminants. The efficacy of this measure depends on the statistical level of sampling and the ability to detect the pests or article of concern (eg. soil). Laboratory testing requires that a portion of each sample taken for inspection be subjected to laboratory analysis for the detection of pathogens.

3.2 Conclusions

All the pests assessed requires mitigative measures, however due to the diverse nature of these pests, it is unlikely that a single mitigative measure will be adequate to reduce the risk to acceptable levels. Consequently, a combination of measures is being suggested as a feasible approach.

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