MINISTRY OF AGRICULTURE AND FISHERIES
PLANT QUARANTINE/PRODUCE INSPECTION BRANCH
PEST RISK ANALYSIS UNIT

Pest Risk Analysis on '*Dickeya solani'*

Symptoms of '*Dickeya solani'* in potato tuber & plant

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Report of a Pest Risk Analysis for '*Dickeya solani'*

This summary presents the main features of a pest risk analysis which has been conducted on the pest.

Pest:	'*Dickeya solani*' (Blackleg of potato)
PRA area:	Jamaica
Assessor:	Sanniel Wilson, Pest Risk Analyst
Date:	February, 2010

STAGE 1: INITIATION

Reason for doing PRA: A new strain of *Erwinia chrysanthemi* (now renamed *Dickeya* spp) has emerged as a common major threat to potato production. The new strain has been reported to be highly aggressive causing disease within three days even at low inoculum levels and with total collapse at warmer temperatures (above 27^{o}C). '*Dickeya solani'* is not known to occur in Jamaica, but has been reported in major seed potato exporting countries. Approximately 95% of the potato produced in Jamaica is propagated from imported seed potatoes. Two of the major seed potato exporters to Jamaica, the Netherlands and Belgium, have been reported to have the pathogen. It was reported that losses due directly to '*Dickeya solani*' in the Netherlands reached £25M in 2007. Seed potato is liable to carry the pathogen in trade/transport and detection of the pathogen at ports of entry is extremely difficult.

Taxonomic position of pest: *Dickeya spp (previously known as Erwinia chrysanthemi*)

'*Dickeya solani*'

Taxonomic position: Bacteria
Common Names: Blackleg of potato

STAGE 2: PEST RISK ASSESSMENT

1. 0 PROBABILITY OF INTRODUCTION

1.1 Entry

Geographical distribution:	In recent years the new, more aggressive species has established itself in a number of European countries (Belgium, Finland, France, Poland, the Netherlands and Spain) and Israel.
Major host plants or habitats:	The major hosts is irish potato (*Solanum tuberosum*)
Which pathway(s) is the pest likely to be introduced on:	The primary pathway for the introduction of the pathogen is the importation of seed and ware potatoes from areas currently reported as having the pathogen. The European countries (Belgium, Finland, France, Poland, the Netherlands and Spain) are reported to have the pathogen.

1.2 Establishment

Plants or habitats at risk in the PRA area:

Jamaica traditionally produces potatoes in seven of the 14 parishes, however with the drive to increase production of the crop; some non-traditional areas will be involved in potato production. The risk to other host plants is unknown and therefore a high level of uncertainty as to whether the pathogen may cause further economic impact exists.

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

The pathogen is known to be aggressive at higher temperatures (25^{o}C to 30^{o}C). Temperatures in Jamaica range from 15 to 33.5 ^{o}C, however the temperature experience for most of the months ranged from 26-32 ^{o}C. Global warming resulting from climate change along with the thrust to increase production of the crop in non-traditional areas will see a greater cultivation of the crop at higher temperatures.

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

The cultivation of irish potato in Jamaica has been increasing and therefore the availability of host for establishment will increase.

Which part of the PRA area is the endangered area:

The major potato producing parishes in Jamaica are Manchester, St. Ann, Clarendon, St. Mary, Westmoreland, Trelawney, and St. Elizabeth. However with the drive to increase the production of potato, small farming of the crop may be occurring outside of the traditional potato areas.

2.0 POTENTIAL ECONOMIC CONSEQUENCES

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

Production losses in Dutch seed potatoes reached €25M in 2007 due to downgrading and rejection of over 20% of stocks during certification, almost entirely due to this new pathogen.

Describe damage to potential hosts in PRA area:

Symptoms caused by *"Dickeya solani"* on the growing plant closely resemble blackleg in many cases. Wilting can be rapid with black soft rotting extending internally up the vascular system of the stem from the infected seed tuber. Symptoms may vary depending on variety and in some, wilting can occur with no obvious sign of
blackleg. High incidences of wilting (as much as 20%) have been observed in England as a result of planting *Dickeya*-infected seed in the warm early season conditions of 2007 and 2009.

How much economic impact would the pest have in the PRA area:

The potential economical impact would come in the form of changes in farm practices, cost of control, surveillance, detection, monitoring, and training personnel for detection; reduced crop yield and subsequent crippling of the potato production sector. If the pathogen were to become established, consumer prices would go up and produce would become less available. This could result in decline in farmers' income and standard of living.

3.0 CONCLUSIONS OF PEST RISK ASSESSMENT

Summarize the major factors that influence the unacceptability risk from this pest:

Estimate the probability of entry:

The pathogen is known to spread through importation of seed and ware potatoes, with Jamaica importing 98% of its seed potato and a significant amount coming from areas where the pathogen is currently distributed coupled with the latent nature of the pathogen, entry of the pest is highly likely.

Estimate the probability of establishment:

Once infected seed or ware potatoes are imported and come in contact with water source or is handled with equipment/utensils that are not sanitized or infested soil and plant material is not properly discarded, the likelihood of establishment and spread is high. The risk is even more likely since farmers occasionally use wares which may appear healthy for cultivation.

Estimate the potential economic impact:

The potential economical impact would come in the form of change in farm practices, cost of control, surveillance, detection, monitoring, and training personnel for detection and reduced crop yield. If the pathogen were to become established, consumer prices would go up and demand reduce. This could result in decline in farmers' income and standard of living. Estimating from the effect of the pathogen seen in the Netherlands, Jamaica's economy will not be able to withstand such potential damage which could cripple sector.

Degree of uncertainty: Medium

OVERALL CONCLUSIONS

The importation of seed potatoes from the Netherlands and Belgium poses a significant risk to Jamaica of becoming infested with the new pathogen 'D *solani'*. The risk of establishment is even greater with the thrust to cultivate Irish potatoes outside of the traditional cool areas which may see potatoes being cultivated at higher temperatures which are ideal for the pathogen development and spread. Temperatures in cultivation areas are also expected to be higher due to the influence of global warming. There however exist a level of uncertainty with regards to the biology of the pest and its establishment potential.

STAGE 3: PEST RISK MANAGEMENT

1.0 Identification of the pathways

Pathways studied in the pest risk management

The importation of seed and ware potatoes is the major pathway identified as a means by which the fungus may enter Jamaica.

Other pathways identified but not studied

Other relevant pathways have not yet been identified.

2.0 Identification of possible measures for pathways

2.0 Measures related to consignment

- The exporting country must carry out inspection and diagnostic testing of samples from consignment to be shipped to Jamaica to ensure the consignment is free from '*Dickeya solani*'.
- Storage within containers should be monitored to avoid soft rot developing.
- Equipment used to handle potato in consignment must be used with great care to prevent damage.

2.1 Measures related to crop or to places of production

- Monitoring for blackleg, slow wilt and blight (particularly tuber blight) in the growing crop will give an indication of the potential for soft rotting in storage.
- The risk of soft rots will be greatly increased if tubers are harvested from wet soils. Avoid poorly drained fields, or take steps to improve the drainage.
- Ensure that harvesting and handling equipment is properly calibrated to minimise tuber damage.

2.3 Measures related to importing country

- Minimize tuber damage during harvesting.
- Source seed with great care; that is, only seeds certified free of '*Dickeya solani*' or seeds from pest free areas should be imported.
- If in doubt, the seeds must be tested before planting.
- Take care with the disposal of soil and waste, especially if you handle foreign ware.
- Proper storage must be adhered to, that includes ensuring low humidity and the separation of seed from ware potatoes.
- Monitor for blackleg and wilt in the growing crop. Avoid using irrigation and poorly drained field.

3.0 CONCLUSION

1.4 Recommended Phytosanitary Measures:

The management and mitigative measures taken by the importing country must be related to the tolerance level of the importing country. Jamaica's heavy reliance on imported seed potato means that a zero tolerance level must be taken. The country's ability to effectively manage the pathogen through surveillance, diagnostic testing as well as eradication programme must also be considered.

The pathogen has caused significant damage amounting to €25 million in the Netherlands alone.

With Jamaica's heavy reliance on imported seed potato for potato production, the economic importance of the crop, the country's small size (increased dispersal potential), the farming culture which will inevitably lead to spread and an already burdened economy, the potential risk to the country if '*Dickeya solani*' becomes established is unacceptable high. **Therefore a phytosanitary certificate is required from the importing country declaring ware and seed potatoes are produced in areas free from '*Dickeya solani*'**

SUPPORTING DATA

STAGE 1: INITIATION

PEST RISK ANALYSIS FOR : 'Dickeya solani'		
Pest Risk Analyst: Sanniel Wilson		
Stage 1: Initiation		
Questions	**Yes/ No/ Score**	**Notes**
1 What is the reason for performing the PRA?		A new strain of *Erwinia chrysanthemi* (now renamed *Dickeya* spp) has emerged as a common major threat to potato production. The new strain has been reported to be highly aggressive causing disease within three days even at low inoculums levels and with total collapse at warmer temperatures (above 27^{o}C). '*Dickeya solani'* is not known to occur in Jamaica, but has been reported in major seed potato exporting countries. Approximately 95% of the potato produced in Jamaica is propagated from imported seed potatoes. Two of the major seed potato exporters to Jamaica, the Netherlands and Belgium, have been reported to have the pathogen. It was reported that losses due directly to '*Dickeya solani*' in the Netherlands reached £25M in 2007. Seed potato is liable to carry the pathogen in trade/transport and detection of the pathogen at port of entry is extremely difficult.
2 Enter the name of the pest		'*Dickeya solani*' (Blackleg of potato)

2A Indicate the type of pest		Bacteria
2B Indicate the taxonomic position		Bacteria
3 Clearly define the PRA area		Jamaica
4 Does a relevant earlier PRA exist?	No	
5 Is the earlier PRA still entirely valid or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)?	N/A	
Stage 2A: Pest Risk Assessment - Pest Categorization		
6 Indicate the specific plant for planting that the pest may be associated with.		Irish potato (*Solanum tuberosum*) seed
6B What is the intended use of the plant?		Jamaica imports potato seeds primarily for planting; some may be occasionally used as ware.
7. Specify the pest distribution		*'D. solani'* infections now responsible for the majority of blackleg cases in the Netherlands. *"D. solani"* has also been found in Belgium, Finland, Spain, France, Israel and Poland. The full distribution is unknown considering the recent discovery of this pathogen.

8. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	**Yes**	As it is now *'Dickeya solani'* is being considered as a new species within the *Dickeya* genus
9. Even if the causal agent of particular symptoms has not yet been fully identified, has it been shown to produce consistent symptoms and to be transmissible?	N/A	
10. Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?	**Yes**	*D. solani* infections are now responsible for the majority of blackleg cases in the Netherlands. Between 2002-2007 annual losses in the Netherlands attributable to *Dickeya* have increased 5 fold from €5million to €25million
11. Does the organism have intrinsic attributes that indicate that it could cause significant harm to plants?	**N/A**	
12 Does the pest occur in the PRA area?	**No**	As reported by the Research & Development Division of Ministry of Agriculture & Fisheries, Jamaica.
13. Is the pest widely distributed in the PRA area?	**N/A**	
14. Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)?	**Yes**	The *Dickeya* genus is known occur on bananas, potatoes, capsicum, carrots, celery, onions, pineapple, tomatoes, sugarcane, sweet potatoes and dasheen. Currently major reports of its presence and damage is on Irish potato (*Solanum tuberosum*).

15. If a vector is the only means by which the pest can spread, is a vector present in the PRA area? (if a vector is not needed or is not the only means by which the pest can spread go to 16)	**No**	'*Dickeya solani'* is spread primarily in potatoes via latent infected seed tubers. In other host plants, the disease is spread by infected propagated vegetative material, infected water course used for irrigation and other secondary hosts or weeds (British Potato Council accessed February 3, 2010)
16. Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?	**Yes**	Experiments carried out by the Food and Environment Research Agency (FERA) under glasshouse conditions have shown the new *Dickeya* strain to be highly aggressive causing disease within 3 days at 22 and 27 ºC, even at low inoculum levels, with total plant collapse at the upper temperature. This is comparable to the average temperatures in the PRA area.
17. With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts (on the environment, on society, on export markets) through the effect on plant health in the PRA area?	**Yes**	
18. This pest could present a risk to the PRA area.	**Yes**	Jamaica imports approximately 98% of the seed potato it uses for potato production; seed potatoes are likely to carry '*Dickeya solani'* latently. The pathogen is more aggressive at higher temperature and in fact can cause total collapse at temperatures higher than 27^{o}C.
19. The pest does not qualify as a quarantine pest for the PRA area and the assessment for this pest can stop.	**N/A**	

Section 2B: Pest Risk Assessment - Probability of introduction/spread and of potential economic consequences

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
		Note: If the most important pathway is intentional import, do not consider entry, but go directly to establishment. Spread from the intended habitat to the unintended habitat, which is an important judgement for intentionally imported organisms, is covered by questions 1.33 and 1.35.
1.1. Consider all relevant pathways and list them		Importation of seed and ware potatoes
1.2. Estimate the number of relevant pathways, of different commodities, from different origins, to different end uses.		Importation of seed and ware potatoes
1.3. Select from the relevant pathways, using expert judgement, those which appear most important. If these pathways involve different origins and end uses, it is sufficient to consider only the realistic worst-case pathways. The following group of questions on pathways is then considered for each relevant pathway in turn, as appropriate, starting with the most important.		Importation of seed and ware potatoes
Pathway n°: This pathway analysis should be conducted for all relevant pathways		

1.4. How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	**Very likely + high**	In the Netherlands, *D. "solani"* has been isolated from field-grown flower bulbs (e.g. hyacinth) in addition to potato- FERA
1.5. How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	**Very likely + high**	The pathogen needs only a small inoculum to cause disease. Seed certification has been used in the Netherlands as the means of control, with 20% of stocks being rejected during the certification in 2007. Additionally low inoculums are needed to cause infection.
1.6. How large is the volume of the movement along the pathway?	**Major + low**	An average of 11 containers of seed potatoes is imported annually. Data received from the Plant Quarantine/Produce Inspection branch of the Ministry of Agriculture in Jamaica.
1.7. How frequent is the movement along the pathway?	**Often + low**	Jamaica imports seed and ware potatoes approximately two times yearly; each period lasting up to four months.
1.8. How likely is the pest to survive during transport/storage?	**Very likely + low**	The pathogen is known to spread by the importation of infested potato seeds. Improper conditions in storage are also known to facilitate its spread. The pathogen has been found on ware crops grown from imported seeds (Science and Advice for Scottish Agriculture –(SASA))
1.9. How likely is the pest to multiply/increase in prevalence during transport /storage?	**Very likely + medium**	Improper conditions in storage such as high humidity may cause water condensation and consequently spread of the pathogen. Since it has been reported that the pathogen is known to invade new areas through seed potato importation, the pathogen must have survived storage and even shipment conditions.
1.10. How likely is the pest to survive or remain undetected during existing management procedures (including	**Very likely +low**	Symptoms caused by '*Dickeya solani'* on the growing plant closely resemble blackleg and sof t rot caused by other pathogens including *Pectobacterium* spp *atrosepticum* and *carotovorum* (SASA). The disease also have a long latent

phytosanitary measures)?		period so visible signs of infection on tubers can take many weeks to appear after harvest -FERA
1.11. In the case of a commodity pathway, how widely is the commodity to be distributed throughout the PRA area?	**Very wide + low**	The major potato producing areas in Jamaica are Manchester, St. Ann, Clarendon, St. Mary, St. Elizabeth and St. Catherine with small backyard farming occurring island wide. Additionally, ware potatoes which are also known to carry the pathogen are sold in markets and supermarkets island- wide. Since contaminated water and machines/equipment can spread this disease, the wide distribution of the ware puts the entire PRA area at risk.
1.12. In the case of a commodity pathway, do consignments arrive at a suitable time of year for pest establishment?	**Yes**	The average temperature in Jamaica remains relative constant throughout the year. The tropical climate that exists in Jamaica has been reported as being ideal for the development of this pathogen.
1.13. How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?		
1.14. In the case of a commodity pathway, how likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	**Likely + medium**	Ware potatoes which are also known to carry the pathogen are sold in markets and supermarkets island-wide. Once in contact with water or machines/equipment, contamination is possible and may lead to the spread of the pathogen. The wide distribution of the ware puts the entire PRA area at risk. The seed potatoes will be taken to the farms for planting where once the tuber is damage; contaminated equipment or water may spread this disease.
1.15. Do other pathways need to be considered?	**No**	
Conclusion on the probability of entry. Risks presented by different pathways.		The trend observed in the EU regarding the spread of this pathogen via the importation of seed potatoes indicates a high probability of the pathogen entering Jamaica on ware and seed potatoes. This probability is further strengthen because the major exporting countries of seed potatoes to Jamaica

		are reported to have the pest and has suffered significant losses.
1.16. Estimate the number of host plant species or suitable habitats in the PRA area (see question 6).	**Very few + high**	With the limited information available on the pathogen only Irish potato is currently being considered as a host in Jamaica
1.17. How widespread are the host plants or suitable habitats in the PRA area? (specify)	**Widely + low**	Jamaica is relatively a small island and from other pest incursion experience, once conditions are appropriate, the possibility of spread is high. A small amount of Irish potato is grown in each parish.
1.18. If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?	**N/A**	
1.19. How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?	**Completely + low**	Experiment done under green house conditions at FERA has indicated that the pathogen is more aggressive at high temperature coupled with high humidity. The tropical climate experienced in Jamaica is therefore ideal for the establishment of this pathogen. With global warming further influencing climate change, higher temperatures are expected.
1.20. How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?	**Largely similar + medium**	High humidity is also considered to be an important factor in the spread of the pathogen. The proximity of farms to water courses in Jamaica may serve as a reservoir for the dispersal of this pathogen through irrigation.
1.21. If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?	**Often + low**	Irish potatoes are not cultivated in protected areas (greenhouse) in Jamaica. However experiments conducted under green house conditions by FERA, showed the new *Dickeya* strain being highly aggressive causing disease within

		three (3) days at 22^{o}C and 27^{o}C.
1.22. How likely is it that establishment will occur despite competition from existing species in the PRA area?	**Very likely + low**	Observations from the Netherlands indicate that once established the new species will rapidly displace others and take over as the principal cause of wilting and blackleg-like symptoms in potato crop- SASA
1.23. How likely is it that establishment will occur despite natural enemies already present in the PRA area?	**N/A**	No natural enemies are known.
1.24. To what extent is the managed environment in the PRA area favourable for establishment?	**Highly favourable + medium**	Irish potatoes are planted and harvested during the periods January to March and September to November. Tractors are used to create furrows during land preparation and sticks, forks and the hand may be used in the harvesting. Irrigation is not widely practiced; however the crop is generally cultivated on slopes or on flat land areas which results in the free flow of water. Since machines and equipment along with the irrigation water may aid in the spreading of this pathogen, the cultivation practices in Jamaica are likely to cause spread if the pathogen is established.
1.25. How likely is it that existing pest management practice will fail to prevent establishment of the pest?	**Very likely + low**	Currently the control measures proposed for '*Dickeya solan'* include seed certification and separation of seeds from ware. Seed certification of potatoes does not occur in Jamaica and with only about four distributors of seed potatoes in the Island, it means that majority of our farmers will be affected once the pests enters.
1.26. Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?	**Likely + high**	The only known biological characteristic about the pathogen is its highly aggressiveness and it ability to multiply at higher temperatures than other blackleg causing pathogen. As it relates to eradication, no country has reported successful eradication of the pathogen.

1.27. How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment**?**	**Very likely + high**	Considering the recent discover of '*Dickeya solani*' and the uncertainty regarding its status as a strain or species, not much is known about its reproductive potential excepting that it may cause disease at low inoculums.
1.28 How likely are relatively small populations to become established?	**Very likely + low**	Experiments carried out by the Food and Environment Research Agency (FERA) under glasshouse conditions have shown the new *Dickeya* strain to be highly aggressive causing disease within 3 days at 22 and 27 ºC, even at low inoculum levels, with total plant collapse at the upper temperature. This is comparable to the average temperatures in the PRA area.
1.29. How adaptable is the pest?	**+ high**	Unknown
1.30. How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances, if possible)	**Often + high**	In the Netherlands, *D. "solani"* has been isolated from field-grown flower bulbs (e.g. hyacinth) in addition to potato. It was first isolated on potato in England and Wales in 2007 and has also been found on potato crops elsewhere in Europe, including Belgium, Finland, France, Israel and Poland. The pathogen has been detected on a single occasion in river water in S.E Scotland but has not been detected there on potatoes.
1.31. If establishment of the pest is very unlikely, how likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment)?	**Very unlikely + low**	Establishment of the pest is very likely
Conclusion on the probability of establishment		The probability of establishment is highly likely considering the ecoclimatic similarity to the present areas in which the pest is established, host availability and cultivation practices.

1.32. How likely is the pest to spread rapidly in the PRA area by natural means?	**Very likely + low**	The spread of the pathogen is largely dependent on distribution of infected seed potatoes, infected free flowing water and infected machinery. With the farming culture that exists in Jamaica, that is the existence of thousands of small farmers, the planting of irish potatoes on terrain or flat land, a small amount of seed potato distributors and likelihood of farmers sharing machinery and equipment; the potential for the pathogen to spread rapidly is high.
1.33. How likely is the pest to spread rapidly in the PRA area by human assistance?	**Very likely+ low**	One of the main dispersal means for the pest is through infected potato seeds. Currently approximately 98% of the seed potatoes used in cultivation is intentionally imported.
1.34. Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?		The pest is unlikely to be contained in one part of the PRA due to the relatively constant temperature experience through the island throughout the island.
Conclusion on the probability of spread		Once established the potential spread of '*Dickeya solani'* throughout the entire island is very likely currently only seed certification is being used to contain the pest.
Conclusion on the probability of introduction and spread The overall probability of introduction and spread should be described. The probability of introduction and spread may be expressed by comparison with PRAs on other pests.	**High + medium**	With the high percentage of seed and ware potatoes that Jamaica imports from regions reported to have the pathogen and the likelihood of the pathogen spreading via irrigation water and machinery coupled with the farming culture in the island (where thousands of small farmers exist that source planting material from the same distributor), the likelihood of the pathogen entering and spreading is high, especially in light of the uncertainties that exist regarding its biology.
Conclusion regarding endangered areas 1.35. Based on the answers to questions 1.16 to 1.34 identify the part of the PRA area where presence of host plants or suitable		The major potato producing parishes in Jamaica are Manchester, St. Ann, Clarendon, St. Mary, Westmoreland, Trelawney, and St. Elizabeth. However with the drive to increase the production of potato, small farming of the crop may be occurring outside of the traditional potato areas. With seven (7) of the

habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.		thirteen (13) parishes being major potato production areas.
2. In any case, providing replies for all hosts (or all habitats) and all situations may be laborious, and it is desirable to focus the assessment as much as possible. The study of a single worst-case may be sufficient. Alternatively, it may be appropriate to consider all hosts/habitats together in answering the questions once. Only in certain circumstances will it be necessary to answer the questions separately for specific hosts/habitats.		
2.1**.** How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?	**Massive +low**	Production losses in Dutch seed potatoes reached €25M in 2007 due to downgrading and rejection of over 20% of stocks during certification, almost entirely due to this new pathogen.
2.2. How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area without any control measures?	**Massive +high**	Currently a 98% of the seed potatoes used in Jamaica is imported from areas where the pest is currently distributed. With only few suppliers of seed potatoes in the island and thousands of small farmers being supplied by the same source, the introduction of the pathogen stands to cause a complete wipe out of potato production areas.
2.3. How easily can the pest be controlled in the PRA area without phytosanitary measures?	**With much difficulty + high**	Based on information now available, no specific control of species in the genus exists on potato in any country. Since the pathogen is seed-borne it is controlled primarily through seed certification in areas where the pest is currently distributed

2.4. How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?	**Major + low**	The potential cost may be significant ranging from changing of normal farm practices, to the cost of control, surveillance, detection, monitoring and training personnel in detection.
2.5. How great a reduction in consumer demand is the pest likely to cause in the PRA area?	**Major+ medium**	Potato is a major source of starch in Jamaica. Though Jamaica depends on imported ware potatoes to adequately meet the demand for the commodity, an outbreak of the pest may cause the country to rely more heavily on external source which could see the cost for potatoes increasing, which may result in reduction in consumers demand**.**
2.6. How important is environmental damage caused by the pest within its current area of distribution?	N/A	The pest principally has a large and unacceptable effect on potato yield and quality. To this end, the less detailed consideration is given to its impact on the environment
2.7. How important is the environmental damage likely to be in the PRA area (see note for question 2.6)?	N/A	
2.8. How important is social damage caused by the pest within its current area of distribution?	**Major+ high**	Establishment of pest free areas may be costly and may reduce the income of farmers in the exporting country who relies on potato exportation for a living
2.9. How important is the social damage likely to be in the PRA area?	**Major + medium**	An outbreak of the pathogen in potato fields in Jamaica will affect the income of many farmers and by extension their family. This in turn could lead to social decline and many social ills.

2.10. How likely is the presence of the pest in the PRA area to cause losses in export markets?	**Likely + high**	Jamaica currently does not export Irish potatoes, however the other possible hosts and their importance in export to Jamaica is unknown.
As noted in the introduction to section 2, the evaluation of the following questions may not be necessary if the responses to question 2.2 is "major" or "massive" and the answer to 2.3 is "with much difficulty" or "impossible" or any of the responses to questions 2.4, 2.5, 2.7, 2.9 and 2.10 is "major" or "massive" or "very likely" or "certain". You may go directly to point 2.16 unless a detailed study of impacts is required or the answers given to these questions have a high level of uncertainty.		Evaluation of sections 2.11 to 2.15 is not necessary.
2.11. How likely is it that natural enemies, already present in the PRA area, will not reduce populations of the pest below the economic threshold?	**N/A**	
2.12. How likely are control measures to disrupt existing biological or integrated systems for control of other pests or to have negative effects on the environment?	**N/A**	
2.13. How important would other costs resulting from introduction be?	**N/A**	
2.14. How likely is it that genetic traits can be carried to other species, modifying their genetic nature and making them more serious plant	**N/A**	

pests?		
2.15. How likely is the pest to cause a significant increase in the economic impact of other pests by acting as a vector or host for these pests?	**N/A**	
2.16. Referring back to the conclusion on endangered area (1.35), identify the parts of the PRA area where the pest can establish and which are economically most at risk.		The major potato producing parishes in Jamaica are Manchester, St. Ann, Clarendon, St. Mary, Westmoreland, Trelawney, and St. Elizabeth. However with the drive to increase the production of potato, small farming of the crop may be occurring outside of the traditional potato areas. With 7 of the 13 parishes being major potato production area.
Degree of uncertainty Estimation of the probability of introduction of a pest and of its economic consequences involves many uncertainties.		Information regarding the pathogen biology, host range and spread is unknown. This results in estimation based on extrapolation from areas where the pathogen is currently distributed.
Evaluate the probability of entry and indicate the elements which make entry most likely or those that make it least likely. Identify the pathways in order of risk and compare their importance in practice.		The pathogen is known to spread through importation of seed and ware potatoes, with Jamaica importing 98% of its seed potato and a significant amount coming from areas where the pathogen is currently distributed coupled with the latent nature of the pathogen, entry of the pest is highly likely.
Evaluate the probability of establishment, and indicate the elements which make establishment most likely or those that make it least likely. Specify which part of the PRA area presents the greatest risk of establishment.		Once infested seed or ware potatoes are imported and comes in contact with water source or is handled with equipment/utensils that are not sanitized or infested soil and plant material is not properly discarded, the likelihood of establishment and spread is high. The risk is even more likely since farmers occasionally use wares which may appear healthy for cultivation.

List the most important potential economic impacts, and estimate how likely they are to arise in the PRA area. Specify which part of the PRA area is economically most at risk.		This would first result in increase cost for management and mitigation, increase in consumer demand and significantly affect the livelihood of many farmers resulting in social decline.
The risk assessor should give an overall conclusion on the pest risk assessment and an opinion as to whether the pest or pathway assessed is an appropriate candidate for stage 3 of the PRA: the selection of risk management options, and an estimation of the associated pest risk.		The import of seed potatoes from Netherland and Belgium poses a significant risk to Jamaica being infested with the new pathogen *D solani*. With the uncertainty in the biology of pest, the significant lost of €25m experienced by the Netherlands in 2007 due to downgrading and rejection of over 20% of stocks during certification, the aggressiveness of the pathogen at high temperatures (27^{o}C)and the entry, establishment and spread of the pathogen is high. The risk of establishment is even greater with the thrust to cultivate Irish potatoes outside of the traditional cool areas which may see potatoes being cultivated at higher temperatures. Increase temperatures in cultivation areas may also be influence by global warming.

Stage 3: Pest Risk Management

Question	**Y/N**	Explanatory text
3.1. Is the risk identified in the Pest Risk Assessment stage an acceptable risk?	**No**	Approximately 98% of the seed potato used in cultivation is imported. The pathogen stands to devastate the entire irish potato farms
Pathway 1		
3.2. Is the pathway that is being considered a commodity of plants and plant products? **If yes, go to 3.11,** **If no, go to 3.3**	**Yes**	Importation of irish potato seeds and ware
3.3. Is the pathway that is being considered the natural spread of the pest? (see answer to question 1.32) **If yes, go to 3.4,** **If no, go to 3.9**	**N/A**	
3.4. Is the pest already entering the PRA area by natural spread or likely to enter in the immediate future? **(see answer to question 1.32)**	**N/A**	
3.5. Is natural spread the major pathway? **If yes, go to 3.29,** **If no, go to 3.6**	**N/A**	

3.6. Could entry by natural spread be reduced or eliminated by control measures applied in the area of origin? **If yes, possible measures: control measures in the area of origin, go to 3.7**	**N/A**	
3.7. Could the pest be effectively contained or eradicated after entry? (see answer to question 1.26, 1.34) **If yes, possible measures: internal containment and/or eradication campaign, Go to 3.8**	**N/A**	
3.8. Was the answer "yes" to either question 3.6 or question 3.7? **If yes, go to 3.38,** **If no, go to 3.44**	**N/A**	
3.9. Is the pathway that is being considered the entry with human travellers? If yes, possible measures: inspection of human travellers, their luggage, publicity to enhance public awareness on pest risks, fines or incentives. Treatments may also be possible**, Go to 3.29** **If no, go to 3.10**	**N/A**	
3.10. Is the pathway being considered contaminated machinery or means of transport? **If yes, possible measures: cleaning or disinfection of machinery/vehicles**	**N/A**	

3.11. If the pest is a plant, is it the commodity itself? **If yes, go to 3.29,** **If no (the pest is not a plant or the pest is a plant but is not the commodity itself), go to 3.12**	**No**	
3.12. Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? **if appropriate, list the measures and identify their efficacy against the pest of concern, Go to 3.13**	**No**	Currently only 3-5% of imported seed and ware potatoes are sampled. With the latent nature of the pathogen and the similarity of symptomatic expressions to other pathogens, it means that this small sample size may not be able to detect infested potatoes and if detected a diagnostic facility must be in place.
3.13. Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import**?** **If yes, possible measure: visual inspection, go to 3.14**	**No**	Visual detection is based on symptomology. The pathogen shows similar symptoms to other pathogen therefore definitive conclusion can only be made through diagnostic testing.
3.14. Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)? **If yes, possible measure: specified testing, go to 3.15**	**Yes**	The polymerase chain reaction along with other molecular tests have been used in Europe to distinguish '*Dickeya solani'* from other pathogen showing similar symptoms
3.15. Can the pest be reliably detected during post-entry quarantine? **If yes, possible measure: import under special licence/permit and post-entry quarantine, go to 3.16**	**Yes**	Currently the initial diagnostic measure being used by Scotland is observation of plant and tuber. Once symptoms are detected, samples should be sent to the laboratory for testing.
3.16. Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)? **If yes, possible measure: specified treatment, go to 3.17**	**No**	No chemical controls are available for this pathogen in the field and in storage. The use of other methods of control is unknown.

3.17. Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? **(This question is not relevant for pest plants)** **If yes, possible measure: removal of parts of plants from the consignment, go to 3.18**	**No**	The pathogen occurs in the tuber both the seed and the ware.
3.18. Can infestation of the consignment be reliably prevented by handling and packing methods? **If yes, possible measure: specific handling/packing methods, go to 3.19**	**Yes**	Monitoring for blackleg, slow wilt and blight (particularly tuber blight) in the growing crop will give an indication of the potential for soft rotting in storage The risk of soft rots will be greatly increased if tubers are harvested from wet soils. Avoid poorly drained fields, or take steps to improve the drainage Ensure that harvesting and handling equipment is properly calibrated to minimise tuber damage Consider testing tubers going into store to predict the soft rot risk. If you are supplying the pre-pack market, both tubers and wash water can be analysed to ensure maximum shelf life Rapid drying after loading and preventing condensation from forming on stored tubers, by appropriate manipulation of temperature and ventilation, is critical Monitor stores closely, and market the crop promptly if soft rots begin to develop
3.19. Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice? **If yes, possible measure: import under special licence/permit and specified restrictions, go to 3.20**	**No**	The primary end use of seed potatoes is for planting. Though the ware is for consumption, the mode of spread for this pathogen as well as the possibility of it being planted is too high of a risk.

3.20. Can infestation of the commodity be reliably prevented by treatment of the crop? **If yes, possible measure: specified treatment and/or period of treatment, go to 3.21**	**No**	No chemical controls are available for this pathogen in the field and in storage. The use of other methods of control is unknown.
3.21. Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants**)** **If yes, possible measure: consignment should be composed of specified cultivars, go to 3.22**	**Unknown**	Unknown
3.22. Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)? **If yes, possible measure: specified growing conditions, go to 3.23**	**No**	Experiments carried out by the Food and Environment Research Agency (FERA)showed infestation of irish potatoes under green house conditions
3.23. Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages? **If yes, possible measure: specified age of plant, growth stage or time of year of harvest, go to 3.24**		Unknown
3.24. Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)? **If yes, possible measure: certification scheme, go to 3.25**	**Yes**	Seed certification has been the main measure being used to control the pathogen in Europe.

3.25.Is the pest of very low capacity for natural spread? If yes, possible measures: pest freedom of the crop, or pest-free place of production or pest-free area**, Go to 3.28** **If no, go to 3.26**	**No**	The pathogen is known to spread through irrigation and other contaminated water source as well through contaminated farming equipment. The fact that the pathogen cannot actively move without been aided would not give it a high capacity of natural spread but its capacity is not very low especially in light of the pattern of spread seen in its current area of distribution.
3.26.Is the pest of low to medium capacity for natural spread? **If yes, possible measures: pest-free place of production or pest free area, Go to 3.28** **If no, go to 3.27**	**No**	
3.27.The pest is of medium to high capacity for natural spread **Possible measure: pest-free area, go to 3.28**	**Yes**	Once the pathogen is established within an area, the possibility of natural spread through the various modes of transmission is medium to high. The level of uncertainty is high pending further studies on the pathogen.
3.28.Can pest freedom of the crop, place of production or an area be reliably guaranteed? **If no, possible measure identified in questions 3.25-3.27 would not be suitable, go to 3.29**	**No**	With the pathogen being able to conceal itself due to it having similar symptoms to other pathogen, reliable guaranteed pest free production area or crop is difficult especially if the pathogen is known to exist in that that area. The classification based on quality of potatoes may serve to reduce the risk of spread to new areas, however with best effort, guaranteed pest free crop would be difficult to attain in light of the latent nature of the pathogen.

3.29. Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts**?** **If yes, possible measures: internal surveillance and/or eradication campaign, go to 3.30**	**Yes**	Several measures could be adapted by the importing country to minimize the probability of establishment of '*Dickeya solani*'. • Source seed with great care that is only seeds certified free of '*Dickeya solani*' or seeds from pest free areas should be imported. • If in doubt, the seeds must be tested before planting. • Take care with the disposal of soil and waste, especially if you handle foreign ware. • Proper storage must be adhered to, that includes ensuring low humidity and the separation of seed from ware potatoes. • Monitor for blackleg and wilt in the growing crop. Avoid using irrigation and poorly drained field. • Minimize tuber damage during harvesting.
3.30. Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest? List them. **If yes, go to 3.31** **If no, go to 3.38**	**Yes**	• Potatoes must be from an area free from '*Dickeya solani.*' Only grade 'A' irish potatoes should be accepted from areas where the pathogen is currently distributed. • Samples of seed and ware potatoes must be sent to post entry quarantine for diagnostic testing prior to being release in the field. • Import seeds from countries such as Canada and Scotland which are not currently infested with '*Dickeya solani*'
3.31. Does each of the individual measures identified reduce the risk to an acceptable level? **If yes, go to 3.34** **If no, go to 3.32**	**Yes**	

3.32.For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level? **If yes, go to 3.34** **If no, go to 3.33**	**N/A**	
3.33.If the only measures available reduce the risk but not down to an acceptable level, such measures may still be applied, as they may at least delay the introduction or spread of the pest. In this case, a combination of phytosanitary measures at or before export and internal measures (see question 3.29) should be considered. **Go to 3.34**	**N/A**	
3.34.Estimate to what extent the measures (or combination of measures) being considered interfere with trade. **Go to 3.35**		Stipulating that irish potatoes must be from '*Dickeya solani'* free area is the most restrictive quarantine measure proposed by IPPC and would require that documented evidence detailing survey/surveillance data to substantiate the claim. Additionally the importing country may ask to verify pathogen free areas. Failure to adequately assure the importing country that potatoes are free from '*Dickeya solani'* may result in the exporting country losing a market.
3.35.Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences. **Go to 3.36**		Establishment of pest free areas may be costly and may reduce the income of farmers in the exporting country who relies on potato exportation for a living.

3.36.Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences? If yes, For pathway-initiated analysis, go to 3.39 For pest-initiated analysis, go to 3.38 If no, go to 3.37	**No**	
3.37.Envisage prohibiting the pathway For pathway-initiated analysis, go to 3.43 (or 3.39), For pest-initiated analysis go to 3.38		
3.38.Have all major pathways been analyzed (for a pest-initiated analysis)? If yes, go to 3.41, If no, Go to 3.1 to analyze the next major pathway	**Yes**	
3.39.Have all the pests been analyzed (for a pathway-initiated analysis)? If yes, go to 3.40, If no, go to 3.1 (to analyze next pest)	**N/A**	

3.40.For a pathway-initiated analysis, compare the measures appropriate for all the pests identified for the pathway that would qualify as quarantine pests, and select only those that provide phytosanitary security against all the pests. Go to 3.41	**N/A**	
3.41.Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment **Go to 3.42**		Jamaica is heavily reliant on imported seed potatoes. The importation of seed potatoes from infested regions is likely to be the pathway by which the pathogen may to enter.
3.42.All the measures or combination of measures identified as being appropriate for each pathway or for the commodity can be considered for inclusion in phytosanitary regulations in order to offer a choice of different measures to trading partners. **Go to 3.43**		• Source seed with great care that is only seeds certified free of '*Dickeya solani*' or seeds from pest free areas should be imported. • If in doubt, the seeds must be tested before planting. • Take care with the disposal of soil and waste, especially if foreign ware was handled. • Proper storage must be adhered to, that includes ensuring low humidity and the separation of seed from ware potatoes. • Monitor for blackleg and wilt in the growing crop. Avoid using irrigation and poorly drained field. • Minimize tuber damage during harvesting
3.43.In addition to the measure(s) selected to be applied by the exporting country, a phytosanitary certificate (PC) may be required for certain commodities. The PC is an attestation by the exporting country that the requirements of the importing country have been fulfilled. In certain circumstances, an additional declaration on the PC may be needed (see EPPO Standard PM 1/1(2): Use of phytosanitary certificates) **Go to 3.44**		

3.44. If there are no measures that reduce the risk for a pathway, or if the only effective measures unduly interfere with international trade (e.g. prohibition), are not cost-effective or have undesirable social or environmental consequences, the conclusion of the pest risk management stage may be that introduction cannot be prevented. In the case of pest with a high natural spread capacity, regional communication and collaboration is important.		The introduction of the pathogen can only be prevented through prohibitive quarantine measures.
Conclusion of Pest Risk Management. **Summarize the conclusions of the Pest Risk Management stage. List all potential management options and indicate their effectiveness. Uncertainties should be identified.**		The management and mitigative measures taken by the importing country must be related to the tolerance level of the importing country. Jamaica's heavy reliance on imported seed potato means that a zero tolerance level must be taken. The country's ability to effectively manage the pathogen through surveillance, diagnostic testing as well as eradication programme must also be considered. The pathogen is known to cause significant damage amounting to €25 million in the Netherlands alone. With Jamaica's heavy reliance on imported seed potato for potato production, the economic importance of the crop, the country's small size (increased dispersal potential), the farming culture which will inevitably lead to spread and an already burdened economy, the potential risk of 'Dickeya solani' establishment is unacceptable high.

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