MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

PLANT PROTECTION DEPARTMENT

DRAFT OF PEST RISK ANALYSIS ON IMPORTATION OF SEED POTATOES (*Solanum tuberosum* L.) FROM SCOTLAND INTO VIETNAM

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1. General introduction

This risk assessment was prepared by Plant Protection Department (PPD), Ministry of Agriculture and Rural Development (MARD) for Scottish Agricultural Science Agency (SASA). Plant pest risks associated with the importation of seed of Potatoes (*Solanum tuberosum*) from Scotland into Vietnam were estimated and assigned the quantitative terms High, Medium or Low in accordance with the template document, *10 TCN 955 : 2006 Specialized standard: Phytosannitary - Pest Risk Analysis Procedure For Imported Plant and Plant Products*.

This risk assessment is one component of a complete pest risk analysis, which described as having three stages: Stage 1 (initiation), Stage 2 (risk assessment) and Stage 3 (risk management).

The commodity is assessed in this report is Seed Potatoes (*Solanum tuberosum*) imported from Scotland to Vietnam. The scientific name of Potato is *Solanum tuberosum* L. (1753) (Solanaceae).

All stages of seed potatoes production in Scotland are under official government control. The certifying authority for seed potatoes is SASA which is responsible for the management and administration of the Seed Potatoes Classification Scheme (SPCS). The SPCS maintains high standards for seed health, purity and operates by exerting official control over initial propagating material, the length of multiplication chain, and application of strict tolerances for diseases, including those caused by viruses.

In Scotland, seed potatoes crops are grown only land which has not had potatoes cultivated on it in the preceding five years (seven years for Pre-Basic) and to be free from Potato Cyst Nematodes (*Globodera rostochiensis* and *Globodera pallida*) and Wart Disease (*Synchytrium endobioticum*) (SASA, 2007).

The classification scheme of Scottish Seed Potatoes includes six steps: Nuclear stock, Pre-basic minitubers, Pre-Basic field grown 1-4, Basic super Elite 1-3, Basic Elite 1-3 and Basic A (Port-of-entry inspection is not considered sufficient to provide phytosanitary security. SASA, 2007).

- Nuclear stock is produced by micro propagation in the government laboratories at SASA. These tissue cultures are subject to stringent testing to ensure freedom from pathogenic organisms. All Scottish seed potatoes crops are derived in this stock.
- Pre-Basic minitubers stocks are the produce of selected clones propagated initially from micro-plants in tissue culture (TC). These micro plants are tested by SASA and prepared to ensure freedom from viruses and from certain fungi and bacteria that can be latent in tubers. Pre-Basic TC seed potatoes are grown from micro-plants in a pathogen free medium.
- Pre-Basic minitubers (PB-TC) may be planted in the field for classification as Pre-Basic (PB) for one to four generations. Pre-Basic class stocks are not often marketed outside Scotland, they form the basis for seed potatoes production in Scotland and provide a continuous input of healthy material to maintain the high standard of all stocks.
- Super Elite crops are derived from Pre-Basic seed which must be 99,95% pure and true to type and within the following disease tolerances (0% Severe mosaic virus, 0,01% leaf- roll virus, 0,05% mild mosaic virus and 0,25% blackleg)
- Elite crops are grown from Pre-basic or Super Elite stocks, which must be 99,95% pure and true to type and within the following disease tolerances (0,1% Severe mosaic/ leaf- roll virus, 0,5% total mosaic/leaf-roll virus and 0,5% blackleg)

- Basic A are collected from stocks which are not meeting the standards for Pre-Basic, Super Elite and Elite, which must be 99,90% pure and true to type and within the following disease tolerances (0,4% Severe mosaic/leaf-roll virus, 0,8% total mosaic/leaf- roll virus and 1,0% blackleg).

All seed potatoes consignment must be packed in their final containers and sealed with official labels before inspection. The official label confirms the identity and class of the consignment. It includes the crop identification number which ensures full traceability of all Scottish seed potatoes consignment (SASA, 2007).

2. Risk Assessment

2.1. Initiating Pest Risk Analysis

Based on 02/2007/NĐ-CP decision on 05 January 2007, 48/2007/QĐ-BNN decision on 29 May 2007 and 34/2007/QĐ-BNN decision on 23 April 2007, before import into Vietnam, some plants and plant products which have highly introduction potential of associated pests must be analysised for pest risk assessment to prevent introduction of the dangerous pests into Vietnam.

2.2. Previous Risk Assessments, Current Status and Pest Interceptions

In the past, there is no previous risk assessment on Seed Potatoes from Scotland. But during inspection in port of entry, Plant Protection Department has detected some serious pests on this commodity. Details of intercepted pest record are given in Table 1. This data will be used in Table 2 for pest categorization.

Table 1. Pest interception on importation of Seed Potatoes *(Solanum tuberosum)* from Scotland into Vietnam

Pest	Origin	Number of interception				Total
		Leaf	Plant	Plant Parts	Seed Tuber	
Spongospora subterranea f. sp. subterranea J.A. Toml.(1)	Scotland				2	**2**
Streptomyces scabies (ex Thaxter 1892) Lambert & Loria, 1989 (2)	Scotland				1	**1**
Grant Total					**3**	**3**

(1) Detection date: June 1997 and November 1998
Growing Place: Muong Xen – Nghe An Province, Vietnam.
(2) Detection date: June 1997
Growing Place: Muong Xen – Nghe An Province, Vietnam.

2.3. Identify Quarantine Pests Likely to Follow the Pathway

Table 2 lists the pests associated with *Solanum tuberosum* that also occur in Scotland and the absence or presence of these pests in Vietnam. Based on table 2, any pest that meets all above criteria will be selected for further assessment (Table 3)

Table 2- Pests Associated with Seed Potatoes *(Solanum tuberosum)* in the Scotland

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
ARTHROPODS					
Coleoptera					
Scarabaeidae					
Melolontha melolontha Linnaneus	Scotland	Flowers, leaves, **tubers**	Yes	Yes	CABI, 2006 EPPO, 2006
Diptera					
Anthomyiidae					
Delia platura Meigen	Scotland	**Whole plant**	Yes	Yes	CABI, 2006 EPPO, 2006
Hemiptera					
Aphididae					
Aulacorthum solani Kaltenbach	Scotland, Vietnam	**Whole plant**	No	Yes	CABI, 2006 EPPT (EPPO Plant Protection Thesaurus) http://www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf Aphids and Aphid-borne virus diseases in potatoes
Myzus persicae Shulzer	Scotland, Vietnam	**Whole plant**	No	Yes	CABI, 2006 EPPO Plant Protection Thesaurus (EPPT) http://www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf Aphids and Aphid-borne virus diseases in potatoes
Macrosiphum euphorbiae Thomas	Scotland	Stem, leaves, flowers	Yes	No	CABI, 2006 CIE, 1984 (Commonwealth Institue of

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
					Entomology) http://www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf Aphids and Aphid-borne virus diseases in Potatoes
Planococcus citri Risso	Scotland, Vietnam	Root, stems, leaves, flowers	No	No	CABI, 2006 www.cababstractsplus.org www.sel.barc.usda.gov/scalekeys/Mealybugs/Key/Mealybugs/Media/html/Species/Planococcus_citri/Planococcus_citri.html
Lepidoptera					
Gelechiidae					
Phthorimaea operculella (Zeller 1873)	Scotland ***Plant quarantine pest of Vietnam (Group II)***	Leaves, stem, root, **tubers**	Yes	Yes	CABI/EPPO, 2006
FUNGI					
Helotiales					
Sclerotiniaceae					
Botrytis cinerea Pers.	Scotland, Vietnam	Leaves, stem, **tubers**	No	Yes	CAB Abstracts, 1973-1998
Chytridiales					
Synchytriaceae					
Synchytrium endobioticum (Schilb.) Percival	Scotland ***Plant quanrantine pest of Vietnam (Group I)***	Leaves, stem, **tubers**	Yes	Yes	CABI/EPPO, 1998; EPPO, 2006

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
Diaporthales					
Valsaceae					
Phoma foveata Foister	Scotland	Stem, leaves, **tubers**	Yes	Yes	CABI, 2006; EPPO, 2006 http://nt.ars-grin.gov/fungaldatabases/
Hypocreales					
Nectriaceae					
Fusarium sulphureum (Fr.) Sacc	Scotland	Seed, stem, **tubers**	Yes	Yes	CABI, 2006 http://www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf
Peronosporales					
Pythiaceae					
Phytophthora drechsleri Kannaiyan et al.	Scotland	**Whole plant**	Yes	Yes	http://nt.ars-grin.gov/fungaldatabases
Phytophthora megasperma Drechsler	Scotland	**Whole plant**	Yes	Yes	CABI, 2006 http://nt.ars-grin.gov/fungaldatabases
Phytophthora infestans (Mont.) de Bary	Scotland, Vietnam	**Whole plant**	No	Yes	http://www.sac.ac.uk/consultancy/cropclinic/clinic/diseases/blight Viện Bảo vệ thực vật, 1977-1978. CABI, 2006
Phyllachorales					
Phyllachoraceae					
Collectotrichum coccodes Wallr.	Scotland. Vietnam	Leaves, stem, root, **tubers**	No	Yes	www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf (Potato tuber diseases) Potato disease, Agricultural

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
					Publish House of HoChiMinh city, 1999, pp.40-49. www.most.gov.vn/doan/bai.asp?code=1227 - 58k http://en.wikipedia.org/wiki/Colletotrichum_coccodes
Plasmodiophorales					
Plasmodiophoraceae					
Spongospora subterranea f. sp. subterranea J.A. Toml.	Scotland, Vietnam	Leaves, stem, root, **tubers**	No	Yes	IMI Herbarium, unda; CMI, 1987 http://nt.ars-grin.gov/fungaldatabases/
Pleosporales					
Pleomassariaceae					
Helminthosporium solani Durieu & Mont	Scotland, Vietnam	Root, **tubers**	No	Yes	http://www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf (Potato tuber diseases) http://data.gbif.org/species/14389327. 2007 Annual Checklist: Species Fungorum.
Polyporales					
Meripilaceae					

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
Polyscytalum pustulans (M.N. Owen & Makef) M.B. Ellis	Scotland	Stem, root, **tubers**	Yes	Yes	CABI, 2006. EPPO, 2006 http://data.gbif.org/species/14386905 http://www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf (Potato tuber diseases)
Ceratobacidiales					
Ceratobacidiaceae					
Rhizoctonia solani (Frank) Donk	Scotland, Vietnam	Root, stem, leaves, flowers, **tubers,** seed	No	Yes	CABI, 2006 Mai, et al. 1993 http://www.sac.ac.uk/mainrep/pdfs/tn486potatotuberdiseases.pdf Viện Bảo Vệ thực vật, 19977-1978.
Hyphomycetales					
Moniliaceae					
Verticillium albo-atrum Reinke & Berthold	Scotland *Plant Quanrantine Pest of Vietnam (Group I)*	Root, stem, leaves, **tubers,** seed	Yes	Yes	CABI, 2006 EPPO, 2006 Major Potato, diseases, insects and Nematode – CIP, 1996. http://www.cipotato.org/publications/pdf/
Verticillium dahliae Kleb.	Scotland, Vietnam	Stem, leaves, seed, root, **tubers**	No	Yes	CABI, 2006 EPPO, 2006 TT GĐKDTV
BACTERIA					
Actinomycetales					
Streptomycetaceae					
Streptomyces scabiei (ex Thaxter 1892) Lambert & Loria, 1989	Scotland, Vietnam	**Tuber**	No	Yes	CABI, 2006; TT GĐKDTV

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
Enterobacteriales					
Enterobacteriaceae					
Erwinia chrysanthemi (Burkh.)	Scotland, Vietnam	Root, stem, leaves, flowers, **tubers**	No	Yes	CABI, 2006 EPPO, 2006
Pectobacterium spp.	Scotland	Leaves, stem, **tubers**, root	Yes	Yes	Bradbury, 1986; IMI, 1996
Pseudomonadales					
Pseudomonadaceae					
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925	Scotland	Whole plant	Yes	Yes	CABI, 2006 EPPO, 2006
Burkholderiales					
Burkholderiaceae					
Ralstonia solanacearum (Smith 1896) Yabuuchi et al. 1996	Scotland, Vietnam	Leaves, stem, root, seed, **tubers**	No	Yes	CABI/EPPO, 2006 Vietnam Institute of Plant Protection
NEMATODES					
Tylenchida					
Anguinidae					
Ditylenchus destructor Thorne, 1945	Scotland *Plant Quanrantine Pest of Vietnam (Group I)*	Root, leaves, vegetative organs, **tubers**	Yes	Yes	CABI/EPPO, 2001; EPPO, 2006 http://www.defra.gov.uk (Potato Tuber Nematode)
Ditylenchus dipsaci (Kuehn, 1857) Filipjev, 1936	Scotland, *Plant Quanrantine Pest of Vietnam (Group II)*	Leaves, **tubers,** vegetative organs, **seed**	Yes	Yes	CABI/EPPO, 1999; EPPO, 2006 http://nematode.unl.edu/ditylenchusdipsaci.htm Nickle, W.R.

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
					1984. Plant and Insect Nematodes. Marcel Dekker, Inc. New York. 925 pages. (page 348).
Heteroderidae					
Globodera pallida (Stone, 1973) Behrens 1975	Scotland *Plant Quanrantine Pest of Vietnam (Group I)*	Root, stem, **tubers**	Yes	Yes	CABI 2006 http://www.eppo.org/QUARANTINE/nematodes/Globodera_pallida/HETDSP_ds.pdf
Globodera rostochinensis (Wollenweder)	Scotland *Plant Quanrantine Pest of Vietnam (Group I)*	Root, stem, **tubers**	Yes	Yes	CABI/EPPO, 1999 EPPO, 2006 www.invasive.org
Triplonchida					
Trichodoridae					
Trichodorus viruliferus Hooper, 1963	Scotland	Root, **tubers**	Yes	Yes	CABI, 2006; EPPO, 2006 http://www.taxonomy.nl/Taxonomicon/TaxonTree.aspx?id=13639
VIRUS					
Bromoviridae					
Alfamovirus					
Alfalfa Mosaic Virus (AMV)	Scotland	**Whole plant**	Yes	Yes	CABI, 2006. EPPO, 2006 www.invasive.org
Picornavirales					
Comoviridae					
Tomato Black Ring Virus (TBRV)	Scotland	**Whole plant**	Yes	Yes	CABI, 2006 EPPO, 2006, Data sheets on quarantine pests.

Pest	Geographic Distribution	Plant Part Affected	Quarantine Pest (Yes/No)	Follow Pathway (Yes/No)	References
					www.invasive.org http://beta.uniprot.org/taxonomy/283677
Mononegavirales					
Bunyaviridae					
Tomato Spotted Wilt Virus (TSWV)	Scotland Vietnam	**Whole plant**	No	Yes	CABI, 2006, EPPO, 2006 www.invasive.org Nguyen Ngoc Bich, 2001-2003; Nguyen Van Bieu, 2005 www.ppd.gov.vn/tapsanbvtv/2005/so5/bai3.htm;
Luteoviridae					
Polerovirus					
Potato Leafroll Virus (PLRV)	Scotland, Vietnam	**Whole plant**	No	Yes	CABI, 2006 Nguyen Van Viet 1989. http://gilb.cip.cgiar.org/confluence/display/wpa/Vietnam?decorator=printable. Bui Cach Tuyen, Vuong Ho Vu, 2005.

Quarantine Pests Likely to be Associated with Seed Potatoes Imported from Scotland

Based on the table 2, Quarantine pests that are reasonably likely to follow the pathway on commercial shipments of seed potatoes *(Solanum tuberosum)* from Scotland included 18 species and were further analyzed in this risk assessment and are summarized in **Table 3.** All of these pests are needed to applied phytosanitary measures to each pest based on risk ratings.

Quarantine pests likely to be associated with *Solanum tuberosum* imported from Scotland and selected for further analysis
Melolontha melolontha Linnaneus (Order: **Coleoptera;** Family: **Scarabaeidae**) *Delia platura* Meigen (Order: **Diptera;** Family: **Anthomyiidae**) *Phthorimaea operculella* (Zeller 1873) (Order: **Lepidoptera;** Family: **Gelechiidae**) *Synchytrium endobioticum* (Schilb.) Percival (Order: **Chytridiales;** Family: **Synchytriaceae**) *Phoma foveata* Foister (Order: **Diaporthales;** Family: **Valsaceae**) *Fusarium sulphureum* (Fr.) Sacc (Order: **Hypocreales;** Family: **Nectriaceae**) *Phytophthora megasperma* Drechsler (Order: **Peronosporales;** Family: **Pythiaceae**)

Polyscytalum pustulans (M.N. Owen & Makef) M.B. Ellis (Order: **Polyporales;** Family: **Meripilaceae**)
Phytophthora drechsleri Tucker (Order: **Pythiales**; Family: **Pythiaceae**)
Verticillium albo-atrum Reinke & Berthold (Order: **Hyphomycetales;** Family: **Moniliaceae**)
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925 (Order: **Pseudomonadales;** Family: **Pseudomonadaceae**)
Ditylenchus destructor Thorne, 1945 (Order: **Tylenchida;** Family: **Anguinidae**)
Ditylenchus dipsaci (Kuehn, 1857) Filipjev, 1936 (Order: **Tylenchida;** Family: **Anguinidae**)
Globodera pallida (Stone, 1973) Behrens 1975 (Order: **Tylenchida;** Family: **Heteroderidae**)
Globodera rostochinensis (Wollenweder) (Order: **Tylenchida;** Family: **Heteroderidae**)
Trichodorus viruliferus Hooper, 1963 (Order: **Triplonchida;** Family**: Trichodoridae**)
Alfalfa Mosaic Virus (AMV) (Family**: Bromoviridae**)
Tomato Black Ring Virus (TBRV) (Order: **Picornavirales;** Family**: Comoviridae**)

2.4. Assess Consequences of Introduction (Table 3)

The undesirable outcomes being considered are the negative impacts resulting from the introduction of quarantine pests. After identifying those quarantine pests that could reasonably be expected to follow the pathway, the assessment of risk continues by considering the consequences of introduction.

For each of these quarantine pests, the potential consequences of introduction are rated using five **Risk Elements**. These elements reflect the biology, host ranges and climatic/geographic distributions of the pests. For each Risk Element, pests are assigned a rating of **low** (1 point), **medium** (2 points) or **high** (3 points). A Cumulative Risk Rating is then calculated by summing all Risk Element values.

Risk Element 1: Climate—Host Interaction

When introduced to new areas, pests can be expected to behave as they do in their native areas if host plants and climates are similar. Ecological zonation and the interactions of the pests and their biotic and abiotic environments are considered in the element. Estimates are based on availability of both host material and suitable climate conditions. To rate this Risk Element, the 7 defined agriculture ecological zones[1] are used. Due to the availability of both suitable host plants and suitable climate, the pest has potential to establish a breeding colony:

Scores are as follows:

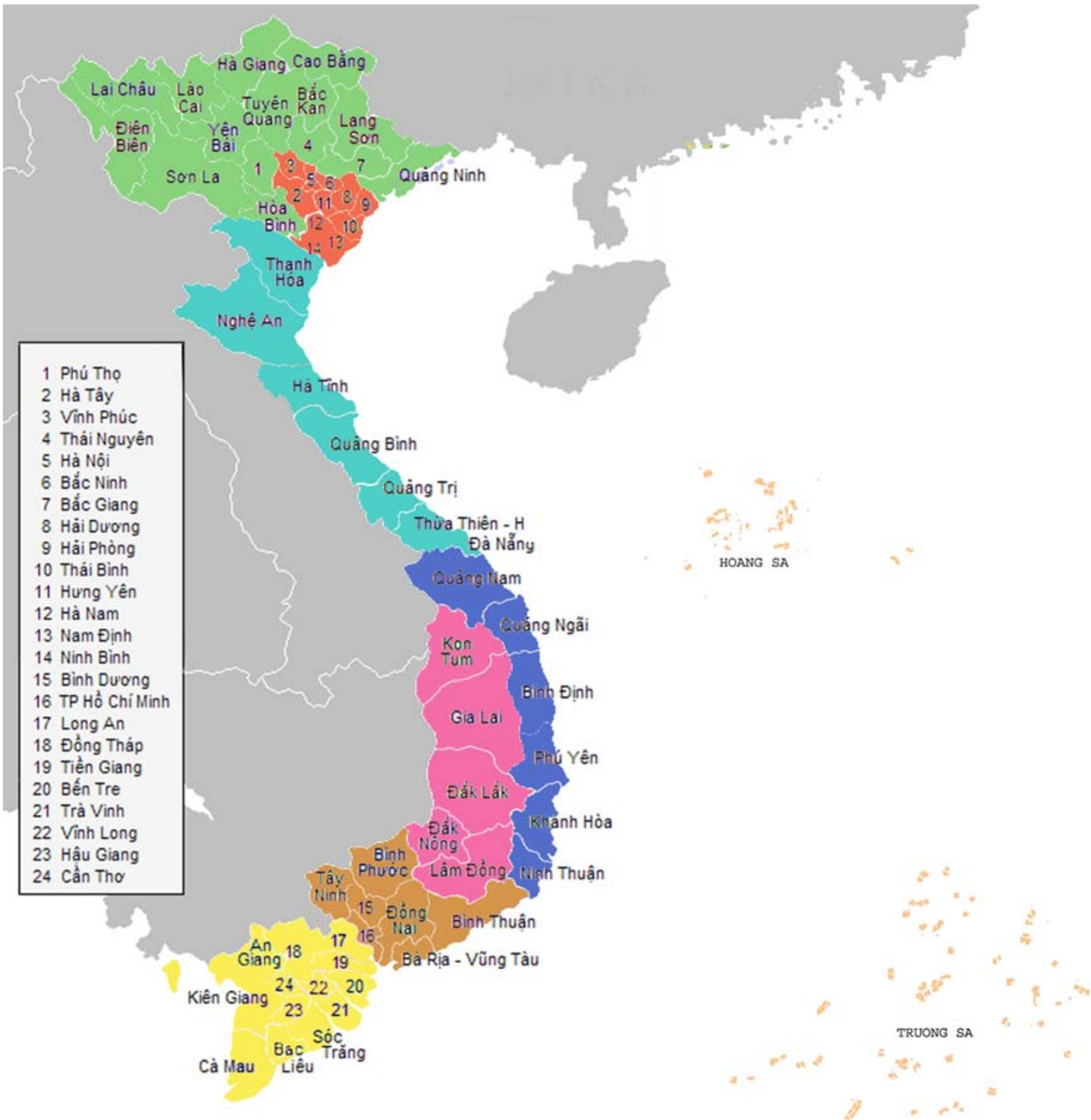
Low: In a single ecological zone……….……….......……. **1 point.**

Medium: In two or three ecological zones……..............…..**2 points**.

High: In four or more ecological zones…...........……….... **3 points**

[1] Seven ecological zones of agriculture included: High land of north mountain, Red river delta, North central coast, South Central coast, Central Highland, Southeast, Cuulong (Mekong) River Delta

Figure 1: Ecological zone map of Agriculture in Vietnam
(Source : NIAPP - MARD, 1997)



Risk Element 2: Host Range

The risk posed by a plant pest depends on both its ability to establish a viable, reproductive population and its potential for causing plant damage. For arthropods, risk is assumed to be correlated positively with host range. For pathogens, risk is more complex and is assumed to depend on host range, aggressiveness, virulence and pathogenicity; for simplicity, risk is rated as a function of host range.

Scores are as follows:

Low: Pest attacks a single species or multiple species within a single genus….....**1 point**

Medium: Pest attacks multiple species within a single plant family…………….. **2 points**

High: Pest attacks multiple species among multiple plant families……................**3 points**

Risk Element 3: Dispersal Potential

A pest may disperse after introduction to a new area. The following items are considered:

- Reproductive patterns of the pest

- Inherent powers of movement

Scores are as follows:

Low: Pest has neither high reproductive potential nor rapid dispersal capability....**1 point**

Medium: Pest has either high reproductive potential or the species is capable of rapid dispersal…………………………………………………………………………......**2 points**

High: Pest has high biotic potential, *e.g.*, many generations per year, many offspring per reproduction ("r-selected" species), and evidence exists that the pest is capable of rapid dispersal, *e.g.*, over 10 km/year under its own power; via natural forces, wind, water, vectors, *etc.*, or human-assistance……………………………………….......................................**3 points**

Risk Element 4: Economic Impact

Introduced pests are capable of causing a variety of direct and indirect economic impacts. These are divided into three primary categories (other types of impacts may occur):

- Lower yield of the host crop, *e.g.*, by causing plant mortality, or by acting as a disease vector.

- Lower value of the commodity, *e.g.*, by increasing costs of production, lowering market price, or a combination.

- Loss of foreign or domestic markets due to presence of new quarantine pest.

Ratings are as follows:

Low: Pest causes any one or none of the above impacts…..........................**1 point**

Medium: Pest causes any two of the above impacts……………….............**2 points**

High: Pest causes all three of the above impacts………………….................**3 points**

Risk Element 5: Environmental Impact

The assessment of the potential of each pest to cause environmental damage proceeds by considering the following factors:

- Introduction of the pest is expected to cause significant, direct environmental impacts, *e.g.*, ecological disruptions, reduced biodiversity.

- Pest is expected to have direct impacts on plant species listed as endangered or threatened in Vietnam[2].

- Pest is expected to have indirect impacts on plant species listed as endangered or threatened by disrupting sensitive, critical habitat.

- Introduction of the pest would stimulate chemical or biological control programs.

Low: None of the above would occur…................**1 point**

Medium: One of the above would occur…............**2 points**

High: Two or more of the above would occur…... **3 points**

[2] This list promulgated with Decree No 32/2006/ND-CP on 30th march 2006 of the Government for managing endangered plants and animals species. Reference: http://www.kiemlam.org.vn.

For each pest, sum the five Risk Elements to produce a Cumulative Risk Rating. This Cumulative Risk Rating is considered to be a biological indicator of the potential of the pest to establish, spread, and cause economic and environmental impacts. The cumulative Risk Rating should be interpreted as follows:

- Low: 5 - 8 points
- Medium: 9 - 12 points
- High: 13 - 15 points

A cumulative Risk Rating is then calculated by summing all risk element values. The values determined for the Consequences of Introduction for each pest are summazied in Table 3.

1. Consequences of Introduction of *Delia platura* (Meigen) (Bean Seed Fly)	**Risk Rating**
Climate/ Host Interaction *Delia platura* is found in Australia, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Norway, Portugal, United Kingdom, United States. Asia: China, Georgia, India, Iran, Isarel, Japan, Korea, Lebanon, Kazakhstan, Nepal, Pakistan, Saudi Arabia, Sri Lanka, Syria, Turkey, Uzbekistan, Yemen (http://zipcodezoo.com/Animals/D/Delia_platura.asp; CABI, 2006). In Vietnam, *Solanum turberosum* is planted over 75 percent of winter plants area in Red River Delta. (MARD, 2006). The complete cycle from egg to adult ranges from 15 to 77 days depending on temperature, oviposition by adults occurs within a temperature range of 10-27°C. (http://wiki.bugwood.org/Delia_platura) Based on this distribution, we estimate that *D. platura* could only become established in four agriculture ecological zones in Vietnam including: High Land of North Mountain, Red River Delta, Noth Central Coast, Centre Highlands. One or more of its potential hosts occurs in these zones.	High (3)
Host range *Delia platura* maggot is extremely polyphagous (more than 40 host plants) and has been recorded to attack multiples species within different families including: **Fabaceae** (bean), **Cucurbitaceae** (melon, cucumber), **Chenopodiaceae** (spinach), **Liliaceae** (asparagus**), Solanaceae** (tomato, tobacco), **Poaceae** (maize), etc. It sometimes extends damage caused by other pests; this is the case in radish, turnip, onion, potato (http://www.inra.fr/hyppz/RAVAGEUR/6delpla.htm).	High (3)
Dispersal Potential Hill (1987) outlined the biology as follows: eggs are laid on disturbed soil, especially in the vicinity of rotting organic matter; each female lays approximately 100 eggs. In the UK there are three to four overlapping generations per year, but this can rise to five in warmer areas. Larvae of *D. platura* may borne internally in roots; they are invisible and liable to disperse by going with roots in trade/transport for long distance movement (Hill 1987).	Medium (2)
Economic Impact	High

Delia platura is a serious pest of seeds and seedlings. Larrain (1994) reported damage to onion seedlings and shallots (*Allium ascalonicum*) in Chile that reached 17.9 and 35.8%, respectively. Chaudhary et al. (1989) found up to six larvae per seed and up to 90% infestation of spring-sown maize in India. There is also some evidence that *D. platura* may transmit some bacterial diseases of plants, namely *Bacillus phytophthorus*, *Erwinia carotovora* and *Erwinia stewartii* [Pantoea stewartii subsp. stewartii] (Griffiths, 1993).	(3)
Environmental Impact *Delia platura* represents a potential threat to many crops. The establishment of it could trigger chemical control programs by using different insecticides that are toxic and harmful to the environment. The standard treatment for control of this pest is to treat preventatively with pre-plant, in-furrow insecticides (http://wiki.bugwood.org/Delia_platura).	Medium (2)
2. Consequences of Introduction of *Melolontha melolontha* Linnaeus (White Grub Cockchafer)	**Risk Rating**
Climate/ Host Interaction *Melolontha melolontha* is found in many countries of Europe: Austria, Belarus, France, Germany, Hungary, Italy, Poland, Portugal, Romania, Sweden, Turkey, United Kingdom. Asia: China (Sichuan), India (Himachal, Pradesh), Turkey. (http://zipcodezoo.com/viruses/m/melolontha_melolontha.asp ;CABI, 2006). At 15°C eggs hatch after 49 days, at 20°C after 32 days and at 25°C after 19 days; in the field mostly after 42 days. Too wet or too hot days in summer can cause high egg mortality. (www.kennisonline.wur.nl/NR/rdonlyres/966B6A33-09E2-4E30-A7A2-57CECF6DD326/30734/BO1000621.pdf) Based on this distribution, we estimate that *M. melolontha* could only become established in four agriculture ecological zones in Viet Nam including: High Land of North Mountain, Red River Delta, Noth Central Coast, Centre Highlands. One or more of its potential hosts occurs in these zones. In Red River Delta, *Solanum tuberosum* is the major plant in winter (over 75 percent of winter plants area in this zone) (MARD, 2006)	High (3)
Host range *Melolontha melolontha* has been recorded to attack multiple species in multiples families including: **Chenopodiaceae** (beetroot), **Rosaceae** (strawberry, apple, raspberry), **Solanaceae** (potato), **Ampelidaceae** (grapevine), etc (CABI, 2006).	High (3)
Dispersal Potential *Melolontha melolontha* female burrows into the soil up to 37.5 cm for oviposition of approximately 24 eggs. A second batch of eggs may be laid 2 weeks later after additional feeding (Woodruff, 1978). Life cycles of 2 and 3 years have been reported in Switzerland and Hungary (Keller, 1993; Homonnay, 1989) under favourable conditions. *Melolontha melolontha* is of quarantine importance in the USA. Some 120 living adults arrived on 38 aircraft in the eastern USA from Paris during April 1961,	Medium (2)

requiring special precautionary measures (Rainwater, 1963).	
Economic Impact The larvae (so-called grubs) are fat and white and have a curved body shape and live in the soil. They can grow up to 46 mm in length. The adults are feeding with leaves and flowers of a range of deciduous trees, but in general they are not a very serious pest on trees. The larvae however, can be very noxious pests of grasses, cereals and other agricultural crops such as potatoes and strawberries, as they live in the soil feeding on the roots. They can be also serious pests in gardens, orchards and tree nurseries. The larvae feed below ground for 3-4 years, before changing into adult beetles. (www.kennisonline.wur.nl/NR/rdonlyres/966B6A33-09E2-4E30-A7A2-57CECF6DD326/30734/BO1000621.pdf) Large populations of *Melolontha melolontha* in the soil can completely destroy the grasses of pasture and turf, which then tend to be replaced by weeds or inferior grasses. Potato tubers may also be severely damaged (Jones and Jones, 1984). In red beet, the attack begins on the rootlets and continues in the stem base; the injured tissue can favour the development of bacterial or fungal diseases. The roots of fruit or forest trees are peeled. Young vine plants can be totally destroyed (http://www.inra.fr/hyppz/RAVAGEUR/6melmel.htm).	Medium (2)
Environmental Impact *Melolontha melolontha* is a serious pest that can threat to many crops. The establishment of it could trigger chemical control programs by using different insecticides that are toxic and harmful to the environment.	Medium (2)

3. Consequences of Introduction of *Phthorimaea operculella* (Zeller 1873)	**Risk Rating**
Climate/ Host Interaction *Phthorimaea operculella* is a cosmopolitan pest, especially in warm temperate and tropical regions where host plants are grown. It has been newly recorded from the Arabian peninsula (Povolny, 1986; Kroschel and Koch, 1994) and more widely in East Africa (Parker and Hunt, 1989). It was also observered in Germany (OP Karsholt, Zoologiste Museum, Copenhagen, Denmark, personal communication, 1996). Development of all stages is greatly influenced by temperature: within an optimum temperature range of 27-35°C, the life cycle is completed in 20-25 days; at 18°C the cycles takes 50-60 days. The maximum fecundity has been recorded at 28°C and temperatures tolerated are in the range 15-40°C. (NIVAA; CABI, 2006). This information indicated that *Phthorimaea operculella* could become established in all agriculture ecological zones in Viet Nam.	High (3)
Host range *Phthorimaea operculella* attacks multiples species within family **Solanaceae**, including: *Solanum tuberosum* (potato), *Capsicum annuum* (bell pepper), *Physalis peruviana* (cape gooseberry), *Solanum melongena* (aubergine), *Lycopersicon esculentum* (tomato), *Nicotiana tabacum* (tobacco). It also has been found on *Beta vulgaris* var. *saccharifera* (sugarbeet) (**Chenopodiaceae**)	High (3)
Dispersal Potential A total of 40-290 eggs are laid on the leaves of the host plant, or on exposed tubers	High (3)

near the eye buds. The larva at first bores into the petiole, or a young shoot or main leaf vein, and mines the leaf making a blotch. Later it bores into a tuber, making a long irregular gallery. The moth can move rapidly and breed continuously where conditions permit; up to 13 generations a year have been recorded in India (Mukherjee, 1948). Plant parts liable to carry the pest in trade/transport are bulbs/tubers/corms/rhizomes (CABI, 2006).	
Economic Impact In the event of a heavy infestation, 5 to 6 larvae may occur in one potato tuber; however, one caterpillar is enough to spoil and destroy. Also fungi and mites develop inside the galleries, causing the decomposition of the tuber and the release of an unpleasant smell. (http://www.inra.fr/hyppz/RAVAGEUR/6phtope.htm). The potato tuberworm is also known as the tobacco splitworm and is becoming a pest in North Carolina. It seems to be interchangeable in the Solanaceae family. In tobacco, the larvae are leaf miners and can cause severe damage to leaves, making them weigh less. (http://en.wikipedia.org/wiki/Phthorimaea_operculella) In 2003, potatoes from several fields in the Columbia Basin of Oregon were rejected for market due to potato tuberworm infestation, resulting in an economic loss of about $2 million (http://extension.oregonstate.edu/catalog/pdf/pnw/pnw594.pdf) In a field study in Egypt with potatoes, tuber yields with abamectin treatment were 14.26t/ha, compared with the control yield of 9.04 t/ha (without treatment, yield loss is about 33%). According to scientific study of PQDC, if potato tuberworm could become established in all regions of Vietnam, the amount of stored pototoes had weigh loss is 90,76%, equal to $30 milion. On the other hand, 100% potatoes loss their trade value (PPD, 2003).	High (3)
Environmental Impact The establishment of *Phthorimaea operculella* on potatoes could trigger methyl bromide fumigation programmes. However, methyl bromide is a toxic and harmful chemical that can depletes the stratospheric ozone layer. According to UK method, at temperature 21-25^{o}C, initial dosage of methyl bromide is used for fumigation is 15-18g/m^{3}, exposure time is 5-6h (EPPO, 1998). (www.eppo.org/MEETINGS/2006_meetings/treatments.htm)	Medium (2)

4. Consequences of Introduction of *Fusarium sulphureum* (Fr.) Sacc (Basal Canker of Hop)	**Risk Rating**
Climate/ Host Interaction *Fusarium sulphureum* **is** probably found world wide. It has been reported on potato tubers from Australia, Canada, Cyprus, East and West Germany, Iran, New Zealand, UK and USA. (CABI). Dry rot (*Fusarium sulphureum* and *Fusarium solani* var *coeruleum*) are historically the most important diseases of stored potatoes. Dry rot is caused by soil-borne *Fusarium sulphureum* which infect through wounds at lifting and grading. Warm, humid storage encourages diseases development. Vietnam's climate characterized by an alternating monsoon and dry season. Temperature fluctuations in growing season of Red River Delta is 26^{0}C (October) to 17^{0}C	High (3)

(February) while at DaLat it is 20^0C (March) and 26^0C (October). Its distribution corresponds to 4 agriculture ecological zones in Vietnam including: High Land of North Mountain, Red River Delta, Noth Central Coast, Centre Highlands.	
Host range *Fusarium sulphureum* has been recorded to attack multiple species in multiple families including: **Liliaceae** *(Allium cepa);* **Poaceae (***Avena sativa, Triticum aestivum, Hordeum vulgara);* **Brassicaceae** *(Brassica juncea var. juncea, Brassica napus var. napus, Brassica nigra);* **Cucurbitaceae** *(Cucumis melo, Cucurbita (pumpkin);* **Caryophyllaceae** *(Gypsophila panicu);* **Cananabaceae** *(Humulus lupulus);* **Fabaceae** *(Medicago sativa, Pisum sativum);* **Pinaceae** *(Pinus strobus);* **Solanaceae** *(Solanum tuberosum),* **Chenopodiaceae** *(Spinacia oleracea).* (CABI, 2006)	High (3)
Dispersal Potential *Fusarium sulphureum* is an important fungus belonging to a group of pathogenic Ascomycetes which cause root and vascular disease in cereal and vegetable crops. Like other Fusarium species, *Fusarium sulphureum* produces three kinds of spores: microspores, macrospores and chlamydospores. Macro- and microspores spread rapidly as large numbers of airborne spores, which act as continual inoculum. Chlamydospores persist in the soil for many years and can be present in the soil clinging to tubers at harvest. (G. A. Secor, 1992). Seed pieces decay when the pathogens infect cut or injured surfaces or when seed potatoes are infected before cutting. Tubers begin to rot either while they are being held after cutting or after they are planted. (*L.E.Hanson et al*). Infection originates in surface wounds during harvest and handing. Like other Fusarium species, *Fusarium sulphureum* disperses readily by soil, water and planting material. (CABI, 2006). Additionally, the species can be dispersed by infested plant materials, such as *Allium cepa, Cucumis melo,Medicago sativa.* (CABI, 2006)	High (3)
Economic Impact Dry rot is probably the most important cause of postharvest potato losses in the northeastern United States and nationwide. (*L.E.Hanson et al)* The storage rot of potatoes caused by *F. sambucium* can be a serious problem; in both Europe and eastern Canada it is known as the common rot of stored potatoes. *Fusarium sulphureum* is economically important as a storage rot of potatoes where it may complete or be associated with *Fusarium sambucium* (*Theo Booth, C. 1971*). For a long time, dry rot was considered the most important cause of storage losses but in recent years, its importance has declined.	Medium (2)
Environmental Impact Dry rot is caused by several fungal species in the genus *Fusarium,* thus the name Fusarium dry rot. The most important dry rot pathogen in the Northeast is *Fusarium sambucinum,* although *Fusarium solani is* also present. Losses appear to be increasing because *Fusarium sambucinum* has become resistant to the benzimidazole fungicides that are commonly used to control dry rot of potato. Thiabendazole (TBZ) has been applied postharvest since the early 1970s to control dry rot in storage. TBZ	Medium (2)

and thiophanate methyl, another benzimidazole fungicide, have been used to prevent decay of seed pieces caused by *Fusarium* species. Resistance to TBZ and other benzimidazole fungicides was discovered in Europe in 1973 and in the United States in 1992.(M. N. Beremand)	
5. Consequences of Introduction of *Phoma exigua* var. *foveata* (Foister) (Potato Gangrene)	**Risk Rating**
Climate/ Host Interaction *Phoma exigua* var. *foveata* is of Andean origin (Otazu *et al*., 1979) and was probably introduced into Scotland (UK) in the 1930s with breeding material (Boerema & van Kesteren, 1981). It has since spread to other potato cultivation areas in Europe and Oceania. **EPPO region**: Present in Estonia, Greece, Latvia, Lithuania, Poland (Wnekowski, 1993). Widespread in Denmark, Ireland, Norway, Sweden and UK (including Guernsey and Jersey); locally established in Belgium, Bulgaria, Cyprus, Czech Republic, Egypt, Finland (Seppanen, 1983), France, Germany, Netherlands, Romania, Slovenia and Switzerland. **Asia**: Cyprus (*P. exigua* var. *exigua*), Yemen. **Africa**: Egypt (Hide, 1986), Morocco (unconfirmed), Sierra Leone, South Africa, Tunisia (found in the past but not established). **North America**: Reports from Canada and USA refer only to *P. exigua* var. *exigua*. **South America**: Andean region, Peru. **Oceania**: Australia (South Australia, Tasmania), New Zealand. **EU**: Present. Based on this distribution, we estimate that *Phoma exigua* var. *foveata* could become established in 4 agriculture ecological zones in Vietnam: High Land of North Mountain, Red River Delta, Noth Central, Centre Highlands. Especially, Red River Delta, *Solanum tuberosum* is the major plant in winter (over 75 percent of winter plants area in this zone) (MARD, 2006)	High (3)
Host range The principal host is potatoes. In its native Andean region, it occurs on intercropped *Chenopodium quinoa* and wild potatoes. The fungus has been isolated from some other cultivated hosts and from certain weeds growing in affected potato crops. Throughout the EPPO region, potatoes (*Solanum tuberosum*) are the host of concern. (CABI, EPPO, 2006)	Low (1)
Dispersal Potential Exposure of tubers to contamination in the field may lead to a degree of true latent infection where the periderm is penetrated, but no further development occurs and the tubers appear healthy. *Phoma exigua* var. *foveata* is readily spread by infected tubers remaining in the soil. (CABI, 2006) Wounding is the single most important factor favouring development of gangrene. The type of wound can also influence severity; more severe gangrene develops from crush wounds than from shallow cuts. Spread of the gangrene fungus to unaffected tubers can occur not only naturally in soil, but also by mechanical transmission of spores on digging and grading equipment. Cold wet soils and cold conditions during handling also favour the development of	Medium (2)

gangrene.	
Economic Impact *Phoma exigua* var. *foveata* is an A2 quarantine organism and details about is biology, distribution and economic importance can be found in EPPO Data Sheet no. 78 (Bulletin OEPP/EPPO Bulletin 12) Planting infected tubers does not generally result in significant yield reduction, although losses of up to 20% have occurred where more than 60% of seed tubers were infected (Smith et al., 1988). Unless the lesions are very large or the soil conditions unsuitable, planting of seed tubers infected with *Phoma exigua* var. *foveata* does not usually reduce yield significantly. However, crops from severely infected seed (over 60% infection) were reported to yield up to 20% less and have an increased proportion of tubers in smaller size grades. In trials with artificially infected seed, yield depressions of up to 60% were reported. Fungicidal sprays in the field may be successful in reducing later incidence of gangrene in store (Cooke & Logan, 1984).	High (3)
Environmental Impact Very little specfic environment impact information is available on *Phoma exigua* var. *foveata*. However, the introduction of *Phoma exigua* var. *foveata* into Vietnam would likely stimulate eradication or control programs similar to those that have been implemented for the species. The species may be successfully controlled by chemical means (dips, fumigation and dusts) (Copeland & Logan, 1975; Carnegie *et al.*, 1988), and disease incidence can be greatly reduced by judicious control of store temperatures. Various fungicides are available which give good control of gangrene, including benomyl, thiabendazole and 2-aminobutane (as a fumigant; OEPP/EPPO, 1984).	Medium (2)

6. Consequences of Introduction of *Phytophthora drechsleri* Tucker (Phytophthora Blight)	**Risk Rating**
Climate/ Host Interaction *Phytophthora drechsleri* was reported as a causal agent of poinsettia foliage blight in 1985 (*Yoshimura, M., M. Aragaki, Plant Dis. 69:511-531*) and of chrysanthemum root rot in 1950 (Frezzi, M. J. Rev. Invest. Agric. Buenos Aires 4:47-133). In Pennsylvania, poinsettia and chrysanthemum root rot caused by Phytophthora drechsleri was detected from July through October in consecutive years between 1997 and 2000. *Phytophthora drechsleri* is a water- and soil-borne fungus, favors warm temperatures (28-31ºC), is highly sensitive to mefenoxam (*Kim, S. H., unpublished*), and has a broad host range of over 100 species. This species is distributed throughout much of subtropical anf tropical regions and it is also reported as present in many countries including: Africa (Egypt, Madagascar, Zimbabwe), Asia (Iran, Japan, Lebanon, Malaysia), Australasia (Australia, New Zealand, Papua New Guinea), Europe (France, Greece, UK), North America (Canada, Mexico, USA), South America (Argentina, Brazil, Colombia) (CMI Map 281, ed. 3, 1979). High humidity and a temperature of 28-32°C are conducive for rapid build-up of the disease in the field. Optimum temperature for growth, sporangia formation and zoospore germination of P. drechsleri f.sp. cajani has been found to be around 25 to	High (3)

30°C (Pal and Grewal, 1984; Singh and Chauhan, 1988). According to Kannaiyan et al. (1980), an optimum temperature range from 27 to 33°C (minimum 9°C and maximum 36°C) supported the growth of *P. drechsleri*. Based on all the above mentioned information, we estimate that *Phytophthora drechsleri* could become established in all the agriculture ecological zones in Vietnam.	
Host range Originaly isolated from rotting potatoes, *Phytophthora drechsleri* has a host range that includes as many as 40 plant families. Host range of this species includes: **Brassicaceae** (*Brassica oleracea* var. *capitata* (cabbage), **Fabaceae** *(Cajanus cajan* (pigeon pea), *Medicago sativa* (lucerne), *Robinia pseudoacacia* (black locust); **Asteraceae** (*Carthamus tinctorius* (safflower), *Helianthus annuus* (sunflower); **Pinaceae** (*Cedrus deodara* (Himalayan cedar), *Pinus radiata* (pine); **Vitaceae** (*Cissus rhombifolia* (grape ivy), **Cucurbitaceae** (*Citrullus lanatus* (watermelon), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita* (pumpkin), *Lagenaria siceraria* (bottle gourd); **Euphorbiaceae** (*Euphorbia pulcherrima* (poinsettia, *Manihot esculenta* (cassava); **Rosaceae** (*Malus domestica* (apple), *Rubus idaeus* (raspberry), *Prunus armeniaca* (apricot); **Anacardiaceae** (*Pistacia vera* (pistachio); **Solanaceae** (*Solanum tuberosum* (potato), *Capsicum annuum* (chili pepper), *Lycopersicon esculentum* (tomato), *Solanum melongena* (eggplant)...	High (3)
Dispersal Potential The Phytophthora blight pathogen (*Phytophthora drechsleri*) is capable of surviving in soil (even in the absence of a living host) and also in infected crop debris for at least one year (Bisht and Nene, 1990). Bisht and Nene (1990) also found zoospores to be the primary source of inoculum, and noted that rain and wind primarily contribute to the dispersal of the inoculum over short distances. Singh and Chauhan (1985) noticed a more rapid development of blight at night in the field, and light was inhibitory to zoospore germination. One of the sources of disease appearance in the field is plant debris mixed with seed material where pigeonpea has not been cultivated for several years. Rainsplash and wind also contribute to short distance dispersal of zoospores (Bisht and Nene, 1990).	High (3)
Economic Impact The disease assumed importance in the early 1980s with the introduction and dissemination of short-duration types of pigeonpea. The disease incidence in West Bengal, India, was as high as 26.3% (*Kannaiyan et al., 1984*) causing enormous crop losses. A severe epidemic occurred in experimental plots at ICRISAT (International Crops Research Institute for the Semi- Arid Tropics), India in the 1975-1976 crop season (*Reddy et al., 1990*). The loss of >84.5% of the plant population was recorded in short duration cultivars by Singh (1996). It was also noticed that infected susceptible plants of variety Pusa 33 rarely survived at IARI (Indian Agricultural Research Institute) in 1995. In South India, total yield loss was observed in some short-duration pigeonpea crops (*Reddy and Sheila, 1994*). The species has a host range that includes as many as 40 plant families, so introduction of the species has the potential to infest plants that are listed as threatened or endangered. (e.g. *Cucumis, Solanum*).	High (3)
Environmental Impact	Medium

Introduction of *Phytophthora drechsleri* into Vietnam is likely to initiate chemical. For example, the systemic fungicide metalaxyl was first developed in the early 1970s (Sandler et al., 1989). It was used against a variety of Phytophthora species causing diseases in different crops including pigeonpea (Kotwal et al., 1981; Chaube et al., 1984; Agrawal, 1987; Chauhan and Singh, 1991a; Singh et al., 1999a). Pal and Grewal (1983) reported fentin acetate + maneb to be the best effective when applied before inoculation. Seed treatment with new formulations of metalaxyl, i.e. mancozeb + metalaxyl, was as effective as an old formulation of metalaxyl in suppressing disease development (Singh et al., 1999a). This fungicide provided maximum protection up to 15 days after sowing (DAS).	(2)

7. Consequences of Introduction of *Phytophthora megasperma* Drechsler (Root Rot)	**Risk Rating**
Climate/Host Interaction *Phytophthora megasperma* is found in Australia, New Zealand, United States, France, Greece, Ireland, Italy, Spain, United Kingdom, Scotland. Asia: *P. megasperma* widespread in Japan, Philippines. (http://zipcodezoo.com/Chromista/P/Phytophthora_medicaginis.asp , CABI, 2006). The optimum soil temperatures for infection of *Phytophthora megasperma* range from 24-27°C. Most isolates of the fungus are active in this temperature range but a high temperature isolate (HTI) has also been identified. It has an optimum temperature range of 27-33°C and a maximum of 39°C. (http://nu-distance.unl.edu/homer/disease/agron/alfalfa/AlfPhyt.html) Based on this distribution, we estimate that *P. megasperma* could become established in 4 agriculture ecological zones in Viet Nam. One or more of its potential hosts occurs in these zones.	High (3)
Host Range *Phytophthora megasperma* has been recorded to attack multiple species in multiples families including: **Liliaceae** (asparagus), **Brassicaceae** (cabbage, cauliflower), **Apiaceae** (carrot), **Solanaceae** (tomato, potato, eggplant), **Rosaceae** (apple, apricot, cherry, plum, peach, strawberry and rose), **Rutaceae** (lemon, grape fruit), **Asteraceae** (sunflower), **Poaceae** (rice, sugar cane), **Sterculiaceae** (cacao), **Cucurbitaceae** (cucumber), **Caryophyllaceae** (carnation), **Lauraceae** (avocado) (CABI, 2006).	High (3)
Dispersal Potential There is no evidence that *Phytophthora megasperma* is seedborne (Richardson, 1979). It can be introduced in diseased nursery stock, so nursery hygiene is essential. Zoospores can be passively spread long distances in irrigation water, or in drainage ditches (Ribeiro and Linderman, 1991).	Medium (2)
Economic Impact Generally, *Phytophthora megasperma* is one of the less aggressive species of Phytophthora, and causes debilitation rather than substantial plant death (CABI, 2006).	Medium (2)

Environment Impact Soil water management techniques, particularly those that minimize prolonged periods of flooding (Wilcox and Mircetich, 1985b), are regarded as one of the most effective ways of managing all diseases caused by *P. megasperma*. The Oomycete-active fungicides have the capacity to slow disease development, but they will not eradicate *P. megasperma* from the soil.	Medium (2)

8. Consequences of Introduction of *Synchytrium endobioticum* (Schilb.) Percival (Wart Disease of Potato)	**Risk Rating**
Climate/Host interation *Synchytrium endobioticum* originated in the Andean zone of South America. It was introduced from there into the UK and from there to continental Europe in the 1880s, and into North America (Newfoundland) in the 1900s. It spread widely throughout the UK and the European continent in the early decades. Especially, its present in China. (Cabi 2006). Temperatures of 12-14^{o}C favor infection (Compendium of potato diseases). This climate is near and the same climates of Vietnam. Based on this distribution, we estimate that *S. endobioticum* could become established into five agriculture ecological zones in Vietnam.	High (3)
Host range The *Synchytrium endobioticum* only cultivated host is potato, but wild species of Solanum are also infected in Mexico. Tomato and a number of other solanaceous plants, including *Schizanthus* sp., *Capsicastrum nanum, Physalis franchetii, Datura* sp. *and Solanum dulcamara* are hosts by artificial inoculation.	Medium (2)
Dispersal potential *Synchytrium endobioticum* is a soil borne fungal parasite which does not produce hyphae, but sporangia containing anywhere from 200-300 motile zoospores. In the spring, at temperatures above 8°C and given sufficient moisture, the overwintering sporangium found in decaying warts in the soil germinate and release uninucleate zoospores. The zoospores possess a single flagellum (tail) which enables them to move in soil water to reach the host. The infected cell swells as the enclosed fungus forms a short-lived but quickly reproducing structure, the summer sporangium, from which numerous zoospores are released to infect neighbouring cells. This cycle of infection and release may be repeated for as long as conditions are suitable, resulting in the host tissue becoming thoroughly infected. (Canadian Food Inspection) (http://www.inspection.gc.ca/english/sci/surv/data/synende.shtml) Soil water can carry zoospores downstream, although the lifespan of a released zoospore is 1-2 hours. Earthworms can move resting spores short distances. Wind is an active dispersal agent in regions of strong dry summer winds. Local dispersal has been shown in resting spores in soil attached to vehicles and contaminated manure. Long-range dispersal by tuber-movement, especially in international trade, attached soil and plants presents problems of control. (CABI, 2006). Once *S. endobioticum* has been introduced into a field, the whole crop may be	High (3)

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.(CABI and EPPO for the EU under Contract 90/399003 – EPPO quarantine pest) The fungus can survive in soil as resting sporangia for as long as 38 years, even through adverse condition.	
Economic impact *Synchytrium endobioticum* is on the A2 quarantine pest list of EPPO (OEPP/EPPO, 1982), and is also of quarantine significance for all the regional plant protection organizations which have established quarantine lists *Synchytrium endobioticum* generally has a much more limited distribution outside of Europe. Indirect losses arising from restrictions on the export of plants from infested areas present a problem to European countries(CABI, 2006)	High (3)
Environmental impact 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. Numerous EPPO publications were devoted to it in the 1950s and 1960s. Very little specific chemical control information on Syn*chytrium endobioticum* and worldwide control of spread is being attempted through quarantine legislation (Compendium of Potato Diseases). According to the recent studies, extraction reagents used were chloroform and calcium chloride in the method described by EPPO, calcium chloride and zinc sulphate in the Plant Protection Service method (PPS method). (C. M. van Leeuwen, J. G. N. Wander)	High (3)

9. Consequences of Introduction of *Verticillium albo-atrum* Reinke& Berthold (Verticillium Wilt)	Risk rating
Climate/Host interation *Verticillium albo-atrum* Reinke& Berthold is almost entirely limited to cool, temperate regions, although it does occur locally on potatoes at high altitude in the tropics and there are reports of a high-temperature strain affecting lucerne in southern California, USA. (CABI, 2006). There are at least two pathotypes of *V. albo-atrum*: lucerne and other hosts (Heale, 1985). Examples of occurrence of *V. albo-atrum* on economically important crops are listed below: China (Xingjiang), Japan, Canada (Alberta, British Columbia, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan), USA (California, Minnesota, Oregon), Brazil, UK , Czech-Republic, Denmark, France, Germany, Netherlands, Poland, Sweden, Switzerland, New Zealand ***(Lucerne)***. Japan, Pakistan, Burundi, Rwanda, Zaire, Canada (Nova Scotia, New Brunswick, Ontario, Prince Edward Island, Quebec, Saskatchewan), USA (Connecticut, Florida, Indiana, Maine, Minnesota, Oregon, Rhode Island), Colombia, Germany, Greece,	High(3)

Poland, Central Russia, UK, Turkey, Tasmania, Victoria, New Zealand ***(Potatoes).*** USA (California), Greece, Slovenia ***(Cucumbers)***. USA(Oregon), France, Germany, Netherlands, Poland, Slovenia, UK, NewZealand ***(Hops)***. Belgium, Greece, Netherlands, UK, Yugoslavia, USA(Iowa), New Zealand ***(Tomatoes)*** China ***(Cotton)*** , Belgium, Poland ***(Sugarbeet)*** ; Denmark ***(Strawberry)*** ; Yugoslavia ***(Sweetpepper)***. Diseases caused by *Verticillium albo-atrum* are favoured by moderate temperature and suppressed by high temperatures. This temperature constraint restricts its distribution as a significant pathogen almost entirely to latitudes greater than about 40° north and 40° South, although disease in potatoes occurs at high altitudes in the tropics, and the southern range of the lucerne pathotype in North America has recently extended, due to the appearance of a high-temperature strain. In the USA, the potato early-dying syndrome is caused mainly by *V. albo-atrum* in those areas where average temperatures during the growing season do not normally exceed 21^0-24°C. Wilt due to *Verticillium albo-atrum* in glasshouse tomato production is suppressed during the summer months when average temperatures exceed 25°-26°C (CABI, 2006). Based on the above mentioned information, we estimate that consequence of introduction of this species is rated to be High. It could become estabished in all agriculture ecological zones in Vietnam where there are many its potential hosts in these zones.	
Host range *Verticillium albo-atrum* has been recorded to attack some species including Major hosts: *Lycopersicon esculentum*(tomato), *Medicago sativa* (lucerne), *Solanum tuberosum* (potato). Minor hosts: *Cucumis sativus* (cucumber), *Humulus lupulus* (hop) Hosts (source - data mining): *Acer platanoides* (Norway maple), *Acer pseudoplatanus* (sycamore)	High (3)
Dispersal potential Verticillium wilt, caused by *Verticillium albo-atrum*, is considered a systemic disease. The pathogen can be isolated from all parts of infected plants, including roots, stems, leaves, flowers, fruits and seeds. The pathogen can be disseminated with infected planting materials such as seeds, tubers (potato) and straw (lucerne hay). Trading of these materials therefore risks the presence of V. albo-atrum in infected seeds, tubers and surface contaminants on these commodities. Non-biotic methods of dispersal of *V. albo-atrum* are air currents and irrigation water. Other physical methods of dispersal of *V. albo-atrum* are contamination of debris of diseased plants and/or particles of infested soil on farm implements such as harvesting machines and vehicles working in the diseased crop. Insect pests such as pea aphid (Huang et al., 1983), alfalfa weevil (Huang and Harper, 1985) and grasshoppers (Huang and Harper, 1985) are effective vectors for transmission of verticillium wilt of lucerne caused by *V. albo-atrum*. The pollinator,	High (3)

leafcutter bee, is another important vector because the bees are capable of cutting diseased leaf pieces for making cocoon and carrying *V. albo-atrum* infected pollen while foraging in the diseased lucerne crop (Huang and Richards, 1983; Huang and Kokko, 1985; Huang et al., 1986a). *Verticillium albo-atrum* is seedborne in lucerne (Sheppard and Needham, 1980; Christen, 1983; Huang et al., 1985) both in the debris that is associated with seed (Isaac and Heale, 1961) and within the seed itself (Christen, 1982b). The seedborne nature of *V. albo-atrum* was also reported in other crops such as safflower (Schuster and Nuland, 1960), lupins (Parnis and Sackston, 1979), celery, sunflower, lettuce, aubergine and Trifolium alsike (*Trifolium hybridum*) (Richardson, 1990) and urd bean (Sharma and Roy, 1991). Colonies moderately fast-growing, white at first, with little aerial mycelium and a regular margin, turning dark-green to blackish green from the centre after 2 weeks or so due to the production of dark, resting mycelium	
Economic impact Since 1997, hop wilt induced by a virulent pathotype of *Verticillium albo-atrum* has caused considerable economic losses in hop fields in Slovenia. During the next 3 years, the lethal form of the disease caused by *V. albo-atrum* spread rapidly through the western part of the Savinja valley and, to date, has affected more than 90 ha of hop fields (25). The disease is currently a serious threat to the main hop production areas in Slovenia.(Cabi, 2006) Over the next six years, the disease spread rapidly and caused considerable economic losses on almost 180 ha of hop gardens in the western part of the Savinja Valley. To prevent further spread, a monitoring survey was performed and strict phytosanitary measures were taken in all infected areas. (S. Radisek, A. Simoncic, J. Jakse, B. Javornik). *Verticillium albo-atrum* continues to cause significant losses in North American lucerne crops. In western Canada, the yearly benefits of growing Verticillium-wilt-resistant and adapted lucerne over wilt-susceptible lucerne was $44 (Canadian dollar) per hetare (Smith et al., 1995). In New Brunswick, Canada, a survey of potato fields in 1991 showed that *Verticillium albo-atrum* was detected in all 37 potato fields surveyed.	High (3)
Environmental impact The European cultivar Vertus was resistant to Verticillium wilt, its poor winter hardiness resulted in lower forage yield than that of the North American resistant cultivars Pioneer 5444, Barrier and AC Blue J (Huang et al., 1994). *Verticillium albo-atrum* are effectively controlled through the use of healthy planting material, resistant cultivars, pathogen-free growing substrates and good husbandry practices (Pegg, 1984)	Medium (2)

10. Consequences of Introduction *of Polyscytalum pustulans* (M.N. Owen & Wakef.) M. B. Ellis (Skin Spot of Potato)	**Risk Rating**

Climate/ Host Interaction The disease is largely restricted to cool temperate regions and the production of conidia requires high humidity (>85% RH) and they develop within 5 days at 16°C (CABI, 2006). Based on this distribution, we estimate that *Polyscytalum pustulans* could only become established in two ecological zones of Vietnam including: High land of North Moutain and Red River Delta. One or more of its potential hosts occurs in these zones.	Medium (2)
Host range *Polyscytalum pustulans* can infect the roots of Solanaceae, including species of Solanum, Nicotiana, Datura and tomatoes, producing brown lesions (Hide, 1981). Its major host is *Solanum tuberosum* (Potato) and the minor host is Solanum (Nightshade) (CABI, 2006).	Low (1)
Disperal Potential The primary source of infection within a crop is largely the seed potatoes (Boyd and Lennard, 1961). Contaminated seed tubers are the main source of inoculum in most seed and ware crops. *P. pustulans* spreads and sporulates first at the base of stems, stolons and roots nearest the mother tuber and then spreads outwards (Hirst and Salt, 1959). The spread and development of skin spot is also enhanced by wet, cool soils during the harvest period. *P. pustulans* can also survive for more than 6 months in dry soil in potato stores and can be dispersed into the air (Carnegie et al., 1978). Infection of healthy tubers can occur from airborne inoculum (Carnegie and Cameron, 1987). *P. pustulans* can be detected in field soil up to 4 years after a potato crop and can cause the infection of healthy tubers (Carnegie and Cameron, 1990). Sporulation from sclerotia in stem tissue buried in soil declines with time until none occurs after 7 years although mycelium is still viable at this time (Hide and Ibrahim, 1994).	High (3)
Economic Impact The affecting seed quality, skin spot, as a skin blemish disease, can reduce the value of the crop when the outlet is as washed pre-packed tubers for the supermarket. Skin blemishes can considerably reduce the return on the crop. Potato processors who store tubers at low temperature and use sprout suppressants can incur increased peeling losses when skin spot develops (French, 1976). Such stocks can be totally unusable and have to be replaced incurring the additional costs of buying replacement stock. As the severity of skin spot increases on tubers, emegence is delayed or prevented and the number of main stems and the number of small tubers is reduced (Hide et al., 1973). The total yield of infected seed stocks was usually significantly lower than that of healthy stocks.	Low (1)
Enviromental Impact The establishment of *Polyscytalum pustulans* in vietnam could trigger the initiation of chemical. Because this disease affects total yield and the size of the tubers (Hide et al., 1973), it is necessary to control the disease. Fungicides can be applied to seed tubers to control disease development on the growing crop and, hence, on daughter tubers.	Medium (2)

11. Consequences of Introduction of *Globodera rostochiensis* (Wollenweber) (Yellow Potato Cyst Nematode)	**Risk Rating**
Climate-Host Interaction *Globodera rostochiensis* distributes large in the world, including the temperate regions of tropical countries (CABI, 2006). The optimum temperature for the hatch of *Globodera rostochiensis* is about 15°C, with the largest proportion of adults in a population at 650-830 day degrees over a basal temperature of 4.4°C (Evans, 1968). Therefore, it can be established in all ecological zones of Vietnam. One or more of its potential hosts occurs in these zones.	High (3)
Host Range *Globodera rostochiensis* has been recorded on a wide range of Solanaceae including: *Lycopersicon esculentum (tomato), Solanum melongena (aubergine), Solanum tuberosum (potato), Datura stramonium (jimsonweed), Lycopersicon pimpinellifolium (currant tomato), Oxalis tuberosa (oca), Solanum (nightshade), Solanum aviculare (kangaroo apple), Solanum gilo (gilo), Solanum indicum , Solanum marginatum (white-edged nightshade), Solanum mauritianum (tree tobacco), Solanum nigrum (black nightshade), Solanum quitoense (Narangillo), Solanum sarrachoides (green nightshade (*UK*)* (CABI, 2006).	Medium (2)
Dispersal Potential Nematodes are dispersed with soil debris and plant material contaminated by the cysts and by infected or contaminated potato tubers (http://nematode.unl.edu/pest6.htm). In general, the potato cyst nematodes will survive in any environment where potatoes can be grown. A period of 38-48 days (depending on soil temperature) is required for a complete life cycle of the potato cyst nematodes (Chitwood and Buhrer, 1945). Potato cyst nematode eggs can remain dormant and viable within the cyst for 30 years (Winslow and Willis, 1972). And After mating, each female produces approximately 500 eggs (Stone, 1973b).	High (3)
Economic Impact Crop losses induced by the golden nematode range 20-70% (Greco, 1988). In Chile, yield losses of 20, 50 and 90% were obtained with population densities of 9.28 and 128 eggs/g soil (Moreno et al., 1984; Greco and Moreno, 1992). In Canada, *Globodera rostochiensis* was found in Newfoundland in 1962 and 800.000$Can /year has been spent on control and research (Miller, 1986). Presence of the golden nematode in potato growing areas precludes the export of potatoes to international markets due to the restrictions imposed by many countries against this pest.	High (3)
Environmental Impact Introduction of *Globodera rostochiensis* into Vietnam is likely to initiate chemical, because it is a serious pest of economically important crops.	High (3)

This species has the potential to attack plants (Solanum) that are main crop in Vietnam. As a large chemical will be used for its controlling. Therefore, it can impacts on ecological system.	

12. Consequences of Introduction of *Ditylenchus destructor* Thorne (Potato Tuber Nematode)	**Risk Rating**
Climate/ Host Interaction *Ditylenchus destructor* is a pest of potatoes mainly in temperate regions: localised areas in North America and many parts of Europe, the mediterranean region and Asia. It was commonly recorded on seed potatoes from the Ural region, Central Asia (Artem'ev, 1976). Problems only occur at temperatures of 15-20°C and at relative humidity above 90% Development and reproduction are possible from 5 to 34^{0}C, with an optimum temperature at 20-27^{0}C. At 27-28^{0}C the development of one generation takes 18 days, at 20-24^{0}C, 20-26 days, at 6-10^{0}C 68 days (Ladygina, 1957; Ustinov and Tereshchenko,1959). In the Alma-Ata region (USSR) six to nine generations developed in potatoes during the vegetation period (accrding to Safyanov; see Decker, 1969). The most serious damage in potatoes was observed at temperatures between 15 and 20^{0}C and 90-100% relative humidity. Based on the information available above, we estimate that *Ditylenchus destructor* could become established in all agriculture ecological zones in Vietnam.	High (3)
Host range *Ditylenchus destructor* has been recorded to attack multiple species in multiple families including: *Allium cepa (onion), Allium sativum (garlic), Arachis hypogaea (groundnut), Beta vulgaris (beetroot), Beta vulgaris var. saccharifera (sugarbeet), Camellia sinensis (tea), Capsicum annuum (bell pepper), Chrysanthemum morifolium (chrysanthemum (florists')), Citrus sinensis (navel orange), Cucumis sativus (cucumber), Cucurbita moschata (pumpkin), Dahlia hybrids , Daucus carota (carrot), Fragaria ananassa (strawberry), Gladiolus hybrids (sword lily), Glycine max (soyabean), Humulus lupulus (hop), Ipomoea batatas (sweet potato), Iris (irises), Lycopersicon esculentum (tomato), Mentha (mints), Panax ginseng (Asiatic ginseng), Solanum melongena (aubergine), Solanum tuberosum (potato), Trifolium (clovers), Triticum aestivum (wheat), Tulipa (tulip), Zea mays (maize).*	High (3)
Dispersal Potential The nematodes can move only short distances in the soil and have no natural means of long-range movement. The main means of dispersal is with infested potato tubers or other subterranean organs of host plants, for example bulbs and rhizomes (especially of iris). Transport in infested soil is another important means of spread. Irrigation water can also carry the nematodes. (CABI,2006) *Ditylenchus destructor* were easily revived from a staste of anabiosis after 1 month. Survival of air dried specimens for up to 5 months is recorded (Gubina,1982). Whereas Makarevskaya (1983) obseved that *D. destructor* survived in plant tissue at temperatured up to -2^{0}C, Ladygina (1956) found that the nematodes survived at -28^{0}C.	Medium (2)

Economic Impact Healthy seed potatoes planted in infested fields in Sweden gave crops damaged by 0.3-94%: severely infested seed tubers gave external symptoms in 41-70% by weight of the new tubers (Andersson, 1971). In general, *Ditylenchus destructor* is of extremely minor importance as a pest of potatoes in the EPPO region. . In recent years it has been detected as a problem in all the groundnut-producing areas of South Africa (Jones & De Waele, 1988). It is suspected that the population in South Africa may be a separate ecotype or pathotype and may be confined to groundnuts; it has not been reported to attack potatoes there.	High (3)
Environmental Impact *Ditylenchus destructor* was considered to be a quarantine pest of Vietnam (Group I). So, introduction of *Phytophthora drechsleri* into Vietnam is likely to initiate chemical. There are some control measures recorded to prevent and eradicate this nematode species, such as: Treatment with soil-applied nematicides can provide a high level of control but can be expensive. Granulated nematicides such as carbofuran were reported to be effective against the nematode (Chukantseva, 1983; Vorona, 1984). *D. destructor* has apparently been eradicated from the state of Wisconsin, USA, by means of repeated fumigation with ethylene dibromide, combined with official restriction of movement of infected tubers (Darling *et al*., 1983).	Medium (2)

13. Consequences of Introduction of *Ditylenchus dipsaci (Kuehn, 1857)* Filipjev (Stem and Bulb Nematode)	**Risk Rating**
Climate/ Host Interaction *Ditylenchus dipsaci* occurs locally in most temperate areas of the world (Europe and the Mediterranean region, North and South America, northern and southern Africa, Asia and Oceania) but it does not seem able to establish itself in tropical regions except at higher altitudes that have a temperate climate. (www.eppo.org/QUARANTINE/nematodes/Ditylenchus_dipsaci/DITYDI_ds.pdf) In Vietnam, *Ditylenchus dipsaci* presented in Hau Giang Province (Nation Institute of Plant Protection, 1977-1978). So far, informations about distribution of this nematode have not reported in Viet Nam. However, there are some temperate places in Vietnam such as, Da Lat, Sa Pa,... and winter in north of Vietnam where grow most host plants of nematode. Base on this distribution, we estimate that *Ditylenchus dipsaci* could become established in more than four ecological areas in Vietnam	High (3)
Host range *Ditylenchus dipsaci* is known to attack over 450 different plant species in multiple families including the principal hosts as **Fabaceae** (*Phaseolus* spp, *Trifolium pratense*, *Trifolium repens*, *Medicago sativa*, *Pisum sativum*, *Vicia faba*,...), **Liliaceae** (*Allium* spp, *Allium cepa*, *Allium porrum*, *Allium sativum*, *Gladiolus hybrids*, *Narcissus pseudonarcissus*, *Tulipa* spp), **Poaceae** (*Zea mays*, *Secale cereale*, *Avena sativa*, *Avena sterilis*, *Triticum* spp.), **Asteraceae** (*Helianthus annuus*), **Solanaceae** (*Solanum tuberosum*, *Nicotiana tabacum*), **Brassicaceae** (*Beta vulgaris* var. saccharifera), **Cannabaceae** (*Cannabis sativa*),...	High (3)

And other host plants such as, minor hosts are *Allium cepa* var. aggregatum (shallot), *Apium graveolens* (celery), *Brassica napus* var. napus (rape), *Carduus acanthoides* (Welted thistle), *Crocus sativus* (saffron), *Cucurbitaceae* (cucurbits), *Dianthus caryophyllus* (carnation), Hydrangea (hydrangeas), *Ipomoea batatas* (sweet potato), *Lens culinaris* ssp. culinaris (lentil), *Onobrychis viciifolia* (sainfoin), *Petroselinum crispum* (parsley), *Phaseolus coccineus* (runner bean). Wild hosts are *Astranti* sp. (winter wild oat), Bergenia (elephant-leaved saxifrage), *Brassica rapa* subsp. rapa (turnip), *Chenopodium murale* (nettleleaf goosefoot), *Cirsium arvense* (creeping thistle), *Convolvulus arvensis* (bindweed), *Hieracium pilosella* (mouse-ear hawkweed), *Lamium album* (white deadnettle), *Lamium amplexicaule* (henbit deadnettle), *Lamium purpureum* (purple deadnettel), *Myriophyllum verticillatum* (whorled watermilfoil), *Nerine sarniensis* (guernsey lily), *Ranunculus arvensis* (Corn buttercup), Raphanus raphanistrum (wild radish), *Stellaria media* (common chickweed), *Taraxacum officinale* complex (dandelion).	
Dispersal Potential The lifecycle of stem and bulb nematode is short (takes approximately 20 days in onion plant at 15^0C). Females lay 200-500 eggs each. They can survive in dry conditions and desiccation for many years. As well as they also survive for years without a host plant Therefore, *Ditylenchus dipsaci* can spread widely by irrigation water, farm tools and machinery and other sources. (CABI,2006; www.eppo.org/quarantine/nematodes/Ditylenchus_dipsaci/DITYDI_ds.pdf). Specially, *Ditylenchus dipsaci* has been shown to be seed-borne on 15 plant species (Neergaard,1977). This means the nematode is wide spread by seeds of crops	High (3)
Economic Impact *Ditylenchus dipsaci* is one of the most devastating plant parasitic nematodes, especially in temperate regions. Without control, it can cause complete failure of host crops. In heavy infestation crop losses of 60-80% are not unusual; e.g., in Italy up to 60% of onion seedlings died before reaching the transplanting stage and for garlic crop losses of about 50% were recorded from Italy and more than 90% from France and Poland. In Morocco *D. dipsaci* was found in 79% of seed stocks of *Vicia faba* examined (nematode.unl.edu/ditdips.htm) *Ditylenchus dipsaci* effects on seed quality because infected seeds are darker, distorted, smaller in size and may speckle-like spots on the surface (Sikora and Greco, 1990). And it has been reported to be seedborne, so the commercial seeds infestation of this nematode can be effected. A survey in the UK showed that it occured widely in economically important crops including 36-45% of seed stocks of broad been, red beet and carrots, 14-17% of shallots, over 3 % of onions and leeks (Green and Sime, 1979). High incidences of seed infection have been reported such as, 67% in broad bean seeds (Stainer and Lanprecht, 1983). Some nations listed *Ditylenchus dipsaci* as plant quarantine pest consist of EPPO, CPPC,IAPSC,NAPPO (www.eppo.org/quarantine/nematodes/Ditylenchus_dipsaci/DITYDI_ds.pdf) and Vietnam.	High (3)
Environmental Impact Very little environmental impact information is available on *Ditylenchus dipsaci*, but treatment of crop seeds with nematicides, methyl bromide fumigation could be	Medium (2)

effected to environmental (Schiffers et al., 1984; Caubel et al., 1985; Whitehead and Tite, 1987; Adamova and Rotrekl, 1991; Hooper, 1991)	

14. Consequences of Introduction of *Globodera pallida* (Stone, 1973) Behrens, 1975 (White Potato Cyst Nematode)	**Risk Rating**
Climate/ Host Interaction The centre of origin of *Globodera pallida* is in the Andes Mountains in South America, then they were introduced to Europe with Potatoes and spreaded with seed potatoes to other areas. The present distribution covers temperate zones down to sea level and in the tropics at higher altitudes (many countries in EPPO region, Asia, Africa, America and Oceania including Scotland). In these areas, distribution is linked with that of the potato crop (www.eppo.org/quarantine/nematodes/globodera-_pallida/HETDSP_ds.pdf, CABI, 2006)). Potato crop distributes in a few agriculture ecological areas such as, the Northern of Vietnam and Da Lat (Centre Highland), espeacially, it takes over 75 percent of winter plants area in Red River Delta (North Vietnam). Base on all information available, we estimate this nematode could become established in all agriculture ecological regions in Vietnam.	High (3)
Host range The hosts of *Globodera pallida* are restricted to the **Solanaceae**. Major hosts are *Lycopersicon esculentum* (tomato), *Solanum melongena (*aubergine) and *Solanum tuberosum* (potato) In addition to many other hosts in the family **Solanaceae** listed as following: *Datura tatula, Lycopersicon glandulosum, L. hirsutum, L. mexicanum, L. esculentum peruvianum, L. pyriforme, Physalis philadelphica, Physochlaina orientalis, Salpiglossis sp., S. acaule, S. aethiopicum, S. ajanhuiri, S. alandiae, S. alatum, S. anomalocalyx, S. antipoviczii, S. armatum, S. ascasabii, S. asperum, S. berthaultii, S. blodgettii, S. boergeri, S. brevimucronatum, S. bulbocastanum, S. calcense, S. calcense, S. cardenasii, S. caldasii, S. canasense, S. capsicibaccatum, S. capsicoides, S. carolinense, S. chacoense, S. chaucha, S. chloropetalum, S. citrillifolium, S. coeruleiflorum, S. commersonii, S. curtilobum, S. curtipes, S. demissum, S. demissum x S. tuberosum, S. dulcamara, S. durum, S. elaeagnifolium, S. famatinae, S. garciae, S. gibberulosum, S. giganteum, S. gigantophyllum, S. gilo, S. glaucophyllum, S. goniocalyx, S. gracile, S. heterophyllum, S. heterodoxum, S. hirtum, S. hispidum, S. indicum, S. intrusum, S. jamesii, S. jujuyense, S. juzepczukii, S. kesselbrenneri, S. kurtzianum, S. lanciforme, S. lapazense, S. lechnoviczii, S. leptostygma, S. longipedicellatum, S. luteum, S. macolae, S. macrocarpon, S. maglia, S. mamilliferum, S. marginatum, S. melongena, S. miniatum, S. multidissectum, S. nigrum, S. nitidibaccatum, S. ochroleucum, S. ottonis, S. pampasense, S. parodii, S. penelli, S. phureja, S. pinnatisectum, S. platypterum, S. polyacanthos, S. polyacanthos S. polyadenium, S. prinophyllum, S. quitoense, S. radicans, S. rostratum, S. rybinii S. salamanii, S. saltense, S. sambucinum, S. sanctae-rosae, S. sarrachoides, S. schenkii S. schickii, S. semidemissum, S. simplicifolium, S. sinaicum, S. sinaicum, S. sisymbrifolium, S. sodomaeum, S. soukupii, S. sparsipilum, S. stenotomum, S. stoloniferum, S. subandigenum, S. sucrense, S. tarijense, S. tenuifilamentum, S. toralopanum, S. triflorum, S. tuberosum ssp. andigena, S. tuberosum ssp. tuberosum, S. tuberosum 'Aquila', S. tuberosum 'Xenia N', S. utile, S.*	Medium (2)

vallis-mexicae, S. vernei, S. verrucosum, S. villosum, S. violaceimarmoratum, S. wittmackii, S. wittonense, S. xanti, S. yabari and *S. zuccagnianum* (Ellenby, 1945, 1954;Mai, 1951, 1952; Winslow, 1955z; Stelter, 1957, 1959, 1987; Roberts and Stone, 1981; http://plpnemweb.cudavis.edu/nemaplex/Taxadata/G053S2.htm)	
Dispersal Potential The cyst of *Globodera pallida* contain as many as 500 eggs, the eggs can remain viable for many years in the absence of solanaceous (25-30-40 years) before gradually deteriorating. this nematode adapts to develop at cool temperatures range of 10^0C to18^0C. Most juveniles go into a form of dormancy known as diapause, in this state, they can remain viable for many years. The lifecycle takes 38-48 days to complete (depending on soil temperature) (Chitwood and Buhrer, 1945; Franco,1979; Stelter, 1971; Stone, 1973b; Jones and Jones, 1974; Golinowski et al.,1997; www.Scotland.gov.uk/consultations/agriculture/pcn-_technical_paper_seerad.pdf). *G.lobodera pallida* have no natural means of dispersal, and can only move the short distances traveled by juveniles attacked towards root in soil. However, Potato Cyst Nematode (*G. pallida*) are usually spread by cysts for long distance by contaminated soil, attached to tuber, plants for transplanting or to farm machinery and other pathway as transport vehicles, non-host plant material, containers and packing and so on (CABI, 2006; www.eppo.org/quarantine/nematodes/globodera-_pallida/HETDSP_ds.pdf	High (3)
Economic Impact *Globodera pallida* are major pests of the potato crop in cool-temperate areas. Damage is related to the number of viable eggs per unit of soil, and is reflected the weight of tubers produced. It has been estimated that approximately 2 tons/ha of potatoes are lost for every 20 eggs/g soil. Up to 80% of the crop can be lost when nematode populations are raise to very high levels by repeated cultivation of potatoes (Brown, 1969). In the UK, potato yields lost 6.25 tons/ha per 20 eggs/g soil (Wood et al., 1995), etc. Beside that, affected plants suffer tubers are smaller (CABI,20060). This means it effects on quality of potato tubers as well as seed potatoes. Control on *Globodera pallida* is major by soil fumigants but fumigant nematicides are toxic and expensive (Mazin, 1991). Moreover, *Globodera pallida* is quarantine pest for EPPO, APPPC, NAPPO and Vietnam (OEPP/EPPO, 1978; 1981; quarantine pest list of Vietnam, 2003).	High (3)
Environmental Impact Apart from using nematicide, methyl bromide was the most effective fumigant available to control *Globodera pallida*. But methyl bromide is an ozone-deleting substance (Thomas, 1996).	Medium (2)

15. Consequences of Introduction of *Trichodorus viruliferus* Hooper (Stubby Root Nematode)	**Risk Rating**
Climate/ Host Interaction Information is given on the geographical distribution in EUROPE, Belgium,	Medium (2)

Bulgaria, France, Germany, Hungary, Italy, Netherlands, Poland, Slovakia, Spain, Sweden, Switzerland, UK, NORTH AMERICA, USA, Florida. *Trichodorus viruliferus* most frequently occurs in sand and sandy-loam soils but occasionally can be found in loam soils. In England, United Kingdom, the life cycle of *T. viruliferus* from egg to adult on apple roots took about 45 days at 15-20°C (Pitcher, 1967; Pitcher and McNamara, 1970). Its distribution corresponds to 2 agriculture ecological zones in Vietnam including: Central Highland (Da Lat), Red River Delta. One or more of its potential hosts occurs in these zones.	
Host range *Trichodorus viruliferus* (TRV) is polyphagous, attacking such crops as: **Brassicaceae** *(Beta vulgaris var. saccharifera* (sugarbeet); **Rosaceae** (*Malus domestica* (apple), **Fabaceae (***Pisum sativum* (pea); **Poaceae** (*Secale cereale* (rye), *Triticum aestivum* (wheat), *Zea mays* (maize), *Hordeum vulgare* (barley); **Solanaceae** (*Solanum tuberosum* (potato).	High (3)
Dispersal Potential *Trichodorus viruliferus* is most prevalent in sandy-loam soils at a depth of 10- 20cm (De Pelsmaeker et al., 1985). It is one of the least tolerant trichodorids to low soil pH (De Pelsmaeker et al., 1985). Reproduction is amphimictic with abundant males, the life cycle lasting about 45 days according to Pitcher and McNamara (1970). Maximal densities occurred in spring and autumn in Belgium (De Pelsmaeker et al., 1987b).	Low (1)
Economic Impact Very little specfic economic impact information is available on *Trichodorus viruliferus*. However, Trichodorid nematodes are widespread and polyphagous and can cause substantial crop damage by their direct feeding on plant roots. *Trichodorus viruliferus* causes direct damage though its feeding, such as root browing, stunting, and the occasional swelling of the root tips. In England, *T. viruliferus* is a vector of FEBV - Pea early browning virus (Gibbs and Harrison, 1964,1968). It is also a vector of Tobacco rattle virus (TRV), causing spraing in potato tubers (van hoof, 1964,1968)	Medium (2)
Environmental Impact Introduction of *Trichodorus viruliferus* into Vietnam is likely to initiate chemical. With chemical control, the majority of the earlier attempts used various volatile nematicidal compounds such as DBCP (1,2-Dibromo-3-chloropropane**)**, EDB (Ethylene Dibromide). Although effective, such products can be both difficult and dangerous to apply and some have now been banned in Europe and the USA. Other , non-volatile, nematicides such as aldicarb, carbofuran, fenamiphos and oxamyl. (D.J. Hunt, 1993)	Medium (2)

16. Consequences of Introduction of *Pseudomonas marginalis* pv. *marginalis* (Brown 1918) Stevens 1925 (Lettuce Marginal Leaf Blight)	**Risk rating**
Climate/Host Interation *Pseudomonas marginalis* pv. *marginalis* (soft rot) probably has a worldwide distribution. It is found in China, Japan, Indonesia, Iran, Korea, Nepal, India, Australia, France, Scotland (CABI, EPPO, 2006). It grew at a temperature range of from 0^0 to 36^0C with optimum temperature of 30^0 – 33^0C. Based on the available information, we estimate that *Pseudomonas marginalis* pv. *marginalis* could become	High (3)

established in all agriculture ecological zones in Vietnam.	
Host range *Pseudomonas marginalis* pv. *marginalis* has been recorded to attack many species in many plant families such as: **Liliaceae** (*Allium cepa* (onion), *Allium sativum* (garlic), *Hyacinthus orientalis* (hyacinth); **Ranunculaceae** (*Anemone coronaria* (Poppy anemone), *Nigella damascena* (Love-in-a-mist*)*; **Apiaceae** (*Apium graveolens* (celery), *Daucus carota* (carrot), *Petroselinum crispum* (parsley); **Chenopodiaceae** (*Beta vulgaris* (beetroot), *Beta vulgaris* var. *cicla* , *Brassica nigra* (black mustard); **Brassicaceae** (*Brassica oleracea* (cabbages, cauliflowers), *Brassica oleracea* var. *botrytis* (cauliflower), *Brassica oleracea* var. *capitata* (cabbage), *Brassica rapa* subsp. *pekinensis* (Pe-tsai), *Raphanus sativus* (radish); **Solanaceae** (*Capsicum annuum* (bell pepper), *Lycopersicon esculentum* (tomato), *Nicotiana tabacum* (tobacco), *Solanum tuberosum* (potato); **Asteraceae** (*Cichorium* (chicory), *Helianthus annuus* (sunflower), *Lactuca sativa* (lettuce), *Lactuca sativa* var. *capitata* (head lettuce); **Cucurbitaceae** (*Cucumis sativus* (cucumber); **Caryophyllaceae** (*Dianthus caryophyllus* (carnation), **Campanulaceae** (*Lobelia erinus* (Dwarf blue lobelia)*;* **Fabaceae** *(Onobrychis viciifolia* (sainfoin), *Phaseolus coccineus* (runner bean), *Phaseolus vulgaris* (common bean), **Araceae** (*Philodendron bipinnatifidum* (lacy tree philodendron); **Salicaceae** (*Populus* (poplars); **Rosaceae** (*Prunus amygdalus*, *Prunus persica* (peach); **Polygonaceae** (*Rheum hybridum* (rhubarb); **Zingiberaceae** (*Zingiber officinale* (ginger). Minor hosts: **Ranunculaceae (***Aconitum napellus* (aconite monkshood); **Liliaceae** (*Agapanthus africanus* (African blue lily), *Allium chinense* (rakkyo); **Bromeliaceae** (*Ananas comosus* (pineapple); **Brassicaceae (***Armoracia rusticana* (horseradish); (*Eutrema wasabi* (Wasabi); **Asteraceae (***Chrysanthemum vestitum* , *Dahlia pinnata* (garden dahlia); **Iridaceae (***Iris germanica* (German iris); **Papaveraceae** (*Papaver somniferum* (Opium poppy); **Primulaceae** (*Primula* (Primrose); **Araceae** (*Syngonium , Syngonium podophyllum* (Arrowhead vine).	High (3)
Dispersal potential *Pseudomonas marginalis* pv. *marginalis* can survive in the soil for a period of up to 4 months when the soil water content is 15-30% and at a temperature of 8°C. At lower moisture levels and/or higher temperatures, survival is lower (Dealto and Surico, 1982).	High (3)
Economic impact Crop losses of up to 40% due to head rot in broccoli have been reported from Canada by Hildebrand (1989). Wimalajeewa et al. (1987) reported a 35% crop loss in the field and over 10% in transit and storage for broccoli with head rot. Severe problems in the field and in storage with onions have been reported from New Zealand (Wright and Hale, 1992). Economic losses arise from reduced marketability of the crop, the presence of diseased stored product, and yield reduction. There are no data available on the economic importance of rots in the field and in storage caused by fluorescent pseudomonades, including *Pseudomonas marginalis* pv. *marginalis* in the European area. In many cases they only appear to be opportunistic pathogens.	High (3)
Environmental impact	Medium

The establishment of *Pseudomonas marginalis* pv. *marginalis* into Vietnam could trigger the initiation of eradication or chemical, similar to those that have occurred with introduction of other Pseudomonas genus in Vietnam. Postharvest fungicide drenches may enhance the incidence of soft rot caused by *Pseudomonas marginalis* pv. *marginalis* (Geeson and Brown, 1979).	(2)
17. Consequences of Introduction of *Alfalfa mosaic virus* (AMV) (Alfalfa Yellow Spot)	**Risk rating**
Climate/Host Interation *Alfalfa mosaic virus* has a world-wide distribution as Europe, Africa, North America, South America, Oceania and Asia (China – Nei menggu, Shaanxi, Taiean and Zhejiang). Based on this distribution, we estimate that AMV could become established in all agriculture ecological zones in Vietnam. There are many its potential hosts occurs in these zones.	High (3)
Host range AMV has a very wide host range infecting at least 697 species in 167 genera of 71 families (Edwardson and Christie, 1997) Major hosts: *Apium graveolens* (celery), *Apium graveolens* var. *rapaceum* (Celeriac), *Capsicum annuum* (bell pepper), *Cicer arietinum* (chickpea), *Cucurbitaceae* (cucurbits), *Glycine max* (soyabean), *Lablab purpureus* (hyacinth bean), *Lactuca sativa* (lettuce), *Lycopersicon esculentum* (tomato), *Medicago sativa* (lucerne), *Nicotiana tabacum* (tobacco), *Phaseolus* (beans), *Solanum tuberosum* (potato), *Trifolium incarnatum* (Crimson clover), *Trifolium pratense* (purple clover), *Trifolium repens* (white clover), *Viburnum opulus* (Guelder rose), *Vigna radiata* (mung bean), *Vigna unguiculata* (cowpea) Minor hosts: *Cajanus cajan* (pigeon pea), *Capsicum* (peppers), *Cercis siliquastrum* (Judas tree), *Coriandrum sativum* (coriander), *Cyphomandra betacea* (tree tomato), *Euonymus japonicus* (japanese spindle), *Eutrema wasabi* (Wasabi), *Hibiscus cannabinus* (kenaf), *Lavandula latifolia* (broadleaved lavender), *Pelargonium* (pelargoniums), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Solanum melongena* (aubergine), *Trifolium subterraneum* (subterranean clover), *Vicia faba* (broad bean), *Vigna angularis* (adzuki bean), *Vinca minor* (common periwinkle), *Vitis vinifera* (grapevine) Wild hosts: *Lotus corniculatus* (bird's-foot trefoil), *Medicago* (medic), *Solanum nigrum* (black nightshade), *Vicia cracca* (Tufted vetch)	High (3)
Dispersal potential AMV is transmitted in the styled-borne or non-persistent manner (Swenson, 1952) by many species of aphids including *Acyrthosiphon possum* and *Myzus persicae* (Edwardson and Christie, 1997). It overwinters in perennial legumes and infected seed and potato tubers provide other sources of virus. AMV has been reported to spread through lucerne crops quite rapidly with its incidence increasing about 1.8 times each year for 5 years (CABI, 2006) AMV is reported to be seedborne in several host species, including Solanum brevidens and *Solanum tuberosum* (Valkonen et al., 1992), *Medicago* spp. (Jones and Pathipanawat, 1989; Jones and Nicholas, 1992; McKirdy and Jones, 1995), *Vicia faba* (Fortass and Bos, 1991), lucerne (Walkey et al., 1990), soyabean (Laguna et al., 1988) and *Trifolium alexandrinum* (Mishra et al., 1980).	High (3)

Economic impact AMV infection of parent lucerne plants can result in a 30-50% reduction in seed germination (Hemmati and McLean, 1977). On the Soybean, AMV infections have been detected at high levels in Nebraska (40% and 26% of fields in 2001 and 2002, respectively) and Wisconsin (28% and 13% of fields in 1999 and 2000, respectively). AMV is of local economic importance in celery, peppers, tomatoes, lucerne, peas, potatoes and *Trifolium* spp. It has a different economic impact on different crop types and the situation in which they are grown. On forage crops it will decrease herbage and root production (see Bailiss and Ollennu, 1986; Jones, 1992). In temperate climates it can reduce the ability of perennial legumes to overwinter (Gibbs, 1962). Infection reduces the flowering and seed yield of *Trifolium subterraneum* (Jones, 1992) and the crop yield of *Vigna angularis* can be reduced by up to 70% (Iizuka, 1990)	Medium (2)
Environmental impact AMV infection of medic seed harvested decreased by up to 76% in insecticide sprayed plots (Jones and Ferris, 2000). AMV is reported to be seedborne in several host species, including *Solanum brevidens* and *Solanum tuberosum* (Valkonen et al., 1992), *Medicago* spp. (Jones and Pathipanawat, 1989; Jones and Nicholas, 1992; McKirdy and Jones, 1995), *Vicia faba* (Fortass and Bos, 1991), lucerne (Walkey et al., 1990), soyabean (Laguna et al., 1988) and *Trifolium alexandrinum* (Mishra et al., 1980).	Medium (2)

18. Consequences of Introduction of *Tomato black ring virus* (TBRV) (Ring Spot of Beet)	**Risk Rating**
Climate/ Host Interation TBRV is common in Europe and has been reported from several other continents. It is found in Albania, Belgium, Bulgaria, Croatia, Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Switzerland, UK, Yugoslavia (Fed. Rep.), ASIA, India, Andhra Pradesh, Karnataka, Tamil Nadu, Japan, Turkey, AFRICA, Kenya, NORTH AMERICA, Canada, Ontario, USA, SOUTH AMERICA, Brazil, Chile. TBRV have broad distribution and established in many areas planting potato in the world, so it's easy for tropical and subtropical climatic conditions to introduce. Based on the available distribution information, we estimate that TBRV could become established in all agriculture ecological zones in Vietnam.	High (3)
Host range TBRV has been recorded to attack multiple species in multiple families including: **Liliaceae** (*Allium cepa* L., *Allium porrum*, Narcissus L.); **Apiaceae** (*Apium graveolens*); **Chenopodiaceae** (*Beta vulgaris* var. *saccharifera*); **Brassicaceae** (*Brassica napus* var. *napobrassica*, *Brassica rapa* subsp. Rapa); **Solanaceae** (Capsicum L., *Solanum tuberosum*, *Lycopersicon esculentum* Mill., nom. cons., *Solanum melongena* L.); **Cucurbitaceae** (*Cucumis sativus* L.); **Asteraceae** (*Cynara*	High (3)

carduncculus L. var. *scolymus* Fiori, *Lactuca sativa* L.); **Rosaceae** (*Fragaria*, *Fragaria ananassa* Duchesne, *Prunus persica* (L.) Batsch), *Rubus* L., nom. cons. prop.); **Iridaceae** (*Gladiolus hybrids*); **Fabaceae** (*Phaseolus vulgaris*); **Grossulariaceae** (*Ribes* L.); **Vitaceae** (*Vitis vinifera* L.). All these crop hosts of TBRV and many wild plants hosts occur widely throughout the EPPO region. In practice, the only important hosts are *Rubus*, *Ribes*, *Fragaria* and some *Prunus* spp. (espeacially peaches). (CABI, EPPO, 2006)	
Disperal Potential TBRV is transmitted by species of the free-living soil-inhabiting nematode, Longidorus (Brown et al., 1996). Isolates of TBRV belonging to the Scottish serotype are transmitted most efficiently by *Longidorus elongatus* (Harrison et al., 1961; Taylor and Murant, 1969), and isolates of the English serotype by *Longidorus attenuatus* (Harrison, 1964). At least 15 species in 12 plant families are known to be infected by TBRV through seed, although most infected seedlings show no obvious symptoms (Lister and Murant, 1967; Murant and Lister, 1967; Murant, 1983). In commercially important plant species including lettuce, beet, tomato and soybean, seed transmission rates of 3, 3-7, 20 and 83% , respectively, were reported (Murant, 1983). Seed transmission of TBRV is an important feature in the epidemiology of the disease because the virus is retained for only a few weeks by its nematode vectors. TBRV therefore relies on its persistence in the seeds of wild plants for survival over winter or through periods of fallow (Lister and Murant, 1967; Murant and Lister, 1967; Murant, 1983; Harrison and Murant, 1996). The virus is also transmitted through seeds of infected plants, often with a high frequency, especially in some crop species and weeds (Lister & Murant, 1967). This enables the virus to be dispersed over a wide area. Additionally, the virus can be dispersed by transport of soil containing TBRV-infected nematodes and/or TBRV-infected seed. In perennial plants, virus may be distributed in material vegetatively propagated from infected plants.	High (3)
Economic Impact In some crop plant species the virus induces severe decline in vigour causing significant losses in productivity both quantitatively and qualitatively (Hollings, 1965; Murant, 1987; Murant and Lister, 1987; Murant et al., 1996). TBRV can cause severe disease in some raspberry, strawberry and cultivars in some localities but the incidence of such infections is often small.(EPPO, 2006)	Medium (2)
Environmental Impact The introduction of TBRV into Vietnam could trigger the initiation of eradication or chemical biological control programs. Avoidance of infection is by planting healthy material (seed of vegetative material) at sites free from infestation with Longidorus vector nematode carrying the virus. At sites contaminated with such infective nematodes, soil treatment with nematicideds prior to planting can be used as a control (Murant&Taylor, 1965; Trudgill&Alphey, 1976).	Medium (2)

Table 3: Summary of Consequences of Introduction

Pest	Risk Element 1	Risk Element 2	Risk Element 3	Risk Element 4	Risk Element 5	Cumulative Risk Rating
Delia platura (Meigen) Order: **Diptera** Family: **Anthomyiidae**	High (3)	High (3)	Medium (2)	High (3)	Medium (2)	**High (13)**
Melolontha melolontha Linnaeus, 1758 Order: **Coleoptera** Family: **Scarabaeidae**	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	**Medium (12)**
Phthorimaea operculella (Zeller 1873) Order: **Lepidoptera** Family: **Gelechiidae**	High (3)	High (3)	High (3)	High (3)	Medium (2)	**High (14)**
Fusarium sulphureum (Fr.) Sacc Order: **Hypocreales** Family: **Nectriaceae**	High (3)	High (3)	High (3)	High (3)	Medium (2)	**High (14)**
Phoma exigua var. *foveata* (Foister) Order: **Diaporthales** Family: **Valsaceae**	High (3)	Low (1)	Medium (2)	High (3)	Medium (2)	**Medium (11)**
Phytophthora drechsleri Tucker Order: **Pythiales** Family: **Pythiaceae**	High (3)	High (3)	Medium (3)	High (3)	Medium (2)	**High (14)**
Phytophthora megasperma Drechsler Order: **Pythiales** Family: **Pythiaceae**	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	**Medium (12)**
Polyscytalum pustulans (M.N. Owen & Makef) M.B. Ellis Order: **Polyporales** Family: **Meripilaceae**	Medium (2)	Low (1)	High (3)	Low (1)	Medium (2)	**Medium (9)**
Synchytrium endobioticum (Schilb.) Order: **Chytridiales** Family:**Synchytriaceae**	High (3)	Medium (2)	High (3)	High (3)	High (3)	**High (14)**
Verticillium albo-atrum Reinke& Berthold Order: **Hypocreales** Family: **Hypocreaceae**	High (3)	High (3)	High (3)	High (3)	Medium (2)	**High (14)**
Ditylenchus destructor Thorne Order: **Tylenchida** Family: **Anguinidae**	High (3)	High (3)	High (3)	High (3)	Medium (2)	**High (14)**
Ditylenchus dipsaci (Kuehn, 1857) Filipjev Order: **Tylenchida** Family: **Anguinidae**	High (3)	High (3)	High (3)	High (3)	Medium (2)	**High (14)**
Globodera pallida (Stone, 1973) Behrens Order: **Tylenchida** Family: **Heteroderidae**	High (3)	Medium (2)	High (3)	High (3)	Medium (2)	**High (13)**
Globodera rostochinensis (Wollenweder)	High (3)	High (3)	High (3)	High (3)	High (3)	**High (15)**

Pest	Risk Element 1	Risk Element 2	Risk Element 3	Risk Element 4	Risk Element 5	Cumulative Risk Rating
Order: **Tylenchida** Family: **Heteroderidae**						
Trichodorus viruliferus Hooper Order:**Trichodorida** Family: **Trichodoridae**	Medium (2)	High (3)	Low (1)	Medium (2)	Medium (2)	**Medium (10)**
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925 Order: **Pseudomonadales** Family: **Pseudomonadaceae**	High (3)	High (3)	High (3)	High (3)	Medium (2)	**High (14)**
Alfalfa mosaic virus Family: **Bromoviridae** Genus: **Alfamovirus**	High (3)	High (3)	High (3)	Medium (2)	Medium (2)	**High (13)**
Tomato black ring virus (TBRV) Family: **Bunyaviridae** Genus: **Tospovirus**	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	**Medium (12)**

2.5. Assess Introduction Potential

1. Sub-element 1- Quantity of commodity imported annually

Rating for the quantity imported annually is based on the amount reported by exporter, and is converted in to standard units 40-foot-long shipping containers. In 2007, Vietnam imported potatoes from some countries such as China, Holland, German and Korea. However, the amount imported annually is the difference among these countries. The rating for the quantity imported annually is based on the amount reported by the Plant Quarantine Sub-Departments, Plant Quarantine Diagnotic Centre and exporters, and is converted into standard units of 40-foot-long shipping containers. The initial volume of seed of Potato to be shipped to Vietnam is less than 10 containers per year; therefore, this risk element is rated **Low (1)** for all pests.

2. Sub-element 2- Survive post harvest treatment

For two arthropod species, as for other species of *Delia*, seed dressing is an important control method, usually with bromophos (Hill, 1987). Trotus and Ghizdavu (1996) found that carbofuran, prometryn, imidacloprid and bifenthrin gave good control. In France, parathion was effective either in the spring of the second year of the cycle against ascending larvae. To control *Melolontha melolontha*, Phoxim was recommended for control of larvae in potato, maize and sugar-beet fields in France by Villeroy and Pourcharesse (1974). So, both *Delia platura* and *Melolontha melolontha* are rated **Low (1)** for this risk element.

The larva of *Phthorimaea operculella* can bores into a tuber, making a long irregular gallery, and safe in transport. For this reason, the ability to survive post-harvest treatment for this pest is rated **High (3).**

For the fungi, *Synchytrium endobioticum* (Schilb.) Percival and *Verticillium albo-atrum* Reinke & Berthold are on the A1 quarantine pests list of Vietnam (MARD, 2005). Chemical treatment of seed have had limited success (Peaden et al., 1985), mainly because of internal infection. Recent work indicates that the pathogen may be eliminated from seed by temperature treatment (Huang et al., 1994). But, temperature treatment with potato will be break potatoes. Therefore, they are rated to be **High (3)** for this risk element.

For skin spot disease (*Polyscytalum pustulans)*, it could be controlled by chemical but its tolerance on tubers is 0.5% and its allowable surface area cover is 12.5% (SASA, 2007). As this is rated **Medium (2)** for this risk element.

The potato cyst nematodes (*Globodera rostochiensis*) are among the most difficult pests to control (Chitwood, 1951). Once established, they are difficult to eradicate because the potato cyst nematodes have one of the highest survival values for any organism, and can survive for over 30 years as eggs protected by the durable cyst wall (Chitwood, 1951; Winslow and Willis, 1972). Moreover, the build-up of nematode populations is slow, and their presence is not easily detected; once the nematode populations increase to high levels, drastic crop losses occur. This is rated **High (3)** for this risk element.

There are many measures to control the fungus such as *Fusarium sulphureum* (Fr.) Sacc, *Phoma exigua* var. *foveata* (Foister), *Phytophthora drechsleri* Tucker and *Phytophthora megasperma* Drechsler. Chemical control is one of the effective measures to prevent these species. For example, gangrene caused by *Phoma exigua* var. *foveata*. may be successfully controlled by chemical means (dips, fumigation and dusts) (Copeland & Logan, 1975; Carnegie *et al*., 1988), and disease incidence can be greatly reduced by judicious control of store temperatures. Effect of application timing of phosphonate on the control of *Phytophthora drechsleri*. When phosphonate was applied into the nutrient solution 4 days before inoculation with *Phytophthora drechsleri*, control efficacy was highest showing over 76% and 94% at 50ppm and 100ppm, respectively. They are rated to be **Medium (2)** for surviving post harvest treatment.

Globodera pallida (Stone, 1973*)* Behrens and *Ditylenchus dipsaci* (Kuchn, 1857) Filijev are on the A1 quarantine pests list of Vietnam (MARD, 2005). Both species of nematode are damaging pests to the potato industry and are difficult to control because cysts and juveniles of *Globodera pallida* and juveniles of *Ditylenchus dipsacci* can survive without their hosts and they are also internal nematode. Therefore, cleaning the soil from potato tubers does not control completely these species (CABI, 2006). So far, we have not had any treatment for post harvest potato tubers by chemical and other methods. Based on above mentioned information , they are rated **High (3)** for this risk element.

Chemical treatment of seed to control *Ditylenchus destructor* and *Trichodorus viruliferus* Hooper have had success, some nematodicides such as ethylene dibromide (EDB). They are rated to be **Medium (2).**

To avoid losses during storage due to soft rot caused by *Pseudomonas marginalis* pv. *marginalis*, damage should be avoided as much as possible and low storage temperatures (close to 1°C) and low humidity should be maintained (Wright, 1993). Controlled storage atmosphere (with higher carbon dioxide levels) may possibly reduce storage rots of tomato (Ibe and Grogan, 1983; Barriga et al., 1989). Post-harvest fungicide drenches may enhance the incidence of soft rot caused by *Pseudomonas marginalis* pv. *marginalis* (Geeson and Brown, 1979). *Poseudomonas marginalis* pv. *marginalis* is rated to be **Medium (2).**

As there is no direct means of controlling the virus (*Tomato spotted wilt virus* (TSWV), *Tomato black ring virus* (TBRV) and *Alfalfa mosaic virus* (AMV)), the method of control must either be aimed at the thrips vectors or involve the application of sanitation measures. Survive post harvest treatment of these viruses are rated to be **High (3).**

3. Sub-element 3- Survive shipment

Most Scottish seed potatoes are transported from Scotland to Vietnam by airway or seaway. Therefore, the period of time taken for plane from Scotland to Noibai Airport is about 1-2 days (airway) and for shipment from Scotland to Vietnam is about 20-25 days (seaway). Secondly, it is packed in wrapping and stored in normal conditions. So the pests could survive during transporting process. All pests are rated **High (3)** for this risk sub-element.

4. Sub-element 4- Not are detected at the port of entry suitable for survival

Larvae of *Delia platura* may borne internally in roots; they are invisible and liable to disperse by going with roots in trade/transport for long distance movement (Hill 1987). This pest is rated **Medium (2)** for this risk sub-element. For *Melolontha melolontha,* according to Jones and Jones (1984) the eggs are round and either white or yellow, elongate-oval, 2 × 3 mm, but increase substantially in size by the absorption of water. This pest is rated **Low (1)** for this risk sub-element. By cutting the infected tuber we can see the gallery and the larvae of *Phthorimaea operculella* inside, so this pest is rated **Medium (2)** for this risk sub-element.

The Phytophthora blight pathogen is soilborne (Bisht and Nene, 1990) and it survives as chlamydospores (Sarkar, 1988) or in the form of oospores (Singh and Chauhan, 1992) in diseased crop debris. It is waterborne, but not seedborne (Reddy et al., 1998). Very little specific symptom information of *Phytophthora drechsleri* on tubers. Therefore, it is very difficult to detect at the port of entry, we estimate that it is rated **High (3)** for this risk element.

Tubers may carry a latent infection of *Phoma exigua* var. *foveata* in the periderm which can not be detected by visual symptoms alone. If tubers are bruised and then incubated at a low temperature (5^0C), any latent infection should develop to give symptoms. It is rate to be **Medium (2).**

For *Polyscytalum pustulans* that causes a skin blemish disease of potato tubers. The symptoms are small, discrete, black or purplish pimples occurring singly or in groups on the tuber surface (French, 1976). Secondly, the size of these funguses is very small. In fact, it would be more difficult to discover. This pest is rated **High (3)** for this sub-element.

Potato cyst nematodes, in common with other cyst nematodes, do not cause specific symptoms of infestation (CABI, 2006). In fact, potato tubers infested with potato cyst nematodes often go unrecognized. To be confident that these symptoms are caused by potato cyst nematodes and to give an indication of population density, soil samples must be taken or the females or cysts must be observed directly on the host roots. They are rated **High (3)** for this risk element.

For *Fusarium sulphureum***,** extensive rotting causes the tissue to shrink and collapse, usually leaving a dark sunken area on the outside of the tuber and internal cavities. Yellow, white, or pink mold may be present. So, infected tubers caused by this fungus species could be easy to discover though symptoms on the surface of tubers. It is rated to be **Low (1).**

According to Barr (1980), *Phytophthora megasperma* produced large oogonia (45-55µm) only when crossed with an isolate of the opposite mating type, but this size is still small and difficult to detect (http://www.jstor.org/pss/3793181). This pest is rated **High (3)** for this risk sub-element.

Verticillium albo-atrum internal infection and temperature requirement for optimum growth is rise up fungi. If temperature requirement has been not optimised this fungi not to growth out, not detected at port of entry. The warts vary from very small protuberances to large intricately branched systems. Because very different diagnostic at post entry. It is rated to be **High (3).** *Synchytrium endobioticum* is one of the most important on potatoes, we can discover it through symptoms on the surface of tubers. However, the infected cell swells as the enclosed fungus forms a short-lived but quickly reproducing structure, the summer sporangium, from which numerous zoospores are released to infect neighbouring cells. It is rated to be **Medium (2).**

As Potato tubers, bulbs, roots, stem, soil adhering potato tubers and transport means liable to carry *Globodera pallida, Ditylenchus dipsacci, Ditylenchus destructor* and *Trichodorus viruliferus* so we can detect them at Port-of-Entry. However, the tiny cysts of *Globodera pallida* (0.5mm in diameter) and small juveniles of these nematode can easily escape unnoticed in the tuber eyes, or in soil that may adhere to tubers at harvest (Jon Pickup and et al., 2002). They are rated **Medium (2)** for this risk element.

For *Pseudomonas marginalis* pv. *marginalis* in storage, a brown to black soft rot occurs, even at low storage temperatures. These symptoms are very similar to those caused by other leaf spot and soft rot causing pseudomonades and Erwinia species and may easily be confused. Laboratory identification is, therefore, necessary (Tsuchiya et al., 1979). Therefore, it is rated to be **High (2).**

Tomato spotted wilt virus (TSWV), *Tomato black ring virus (*TBRV) and *Alfalfa mosaic virus* (AMV)) are latent diseases and only suitable hosts and vectors are infected viruses. They are rated to be **High (3).**

5. Sub-element 5- Imported or moved subsequently to an area with an environment suitable for survival

Delia platura is more popular in temperate areas (European country) (CABI, 2006), however, Vietnam is a tropical country. This pest is rated **Low (1)** for this risk sub-element. *Melolontha melolontha* appears mainly in template areas (European country) (CABI, 2006). This pest is rated **Medium (2)** for this risk sub-element. Major hosts of *Phthorimaea operculella* (potato, tomato…) are grown in all ecological zones in Vietnam, the abitity to contact with an environment suitable for survival for this pest is **High (3)**.

Fusarium sulphureum, Phoma exigua var. *foveata*, *Phytophthora drechsleri* and *Phytophthora megasperma* is probably found world wide and could become established in many potato planting areas in the world, especially, warm, humid storage encourages diseases development. (CABI, 2006). Therefore, Red River Delta zone is the place has sub-tropical and tropical climate conditions suitable for survival of this fungus species. They are rated **High (3)** for this risk element.

The wart disease occur at all soil pH values, the optimum temperature range for infection is 12-14^{0}C. *Synchytrium endobioticum* can be survived in soil as resting sporangia for as long as 38 years, even through adverse condition. *Verticillium albo-atrum* is growing at optimum temperature range 25-26^{0}C. Therefore, these pest are rated **High (3)** for this risk element.

Potato tubers from Scotland are likely to be grown in every province in Vietnam. Based on their known cool temperate regions destructions, it is estimated that climates would be suitable for *Polyscytalum pustulans* to establish permanent populations in High land of North Mountain and Red River Delta zone. This pest is rated **Medium (2)** for this risk element. *Globodera rostochiensis* is recorded in the temperate regions of tropical countries, so it could be suitable climatic conditions in almost ecological zones in Vietnam for pest survival. This pest is rated **High (3)** for this risk element.

Vietnam annual imported 10 containers per year of potato tubers and they are sold in every regions. In otherwords, the climate condition in growing potato crop areas (Northern Vietnam and Dalat) is adapted to these nematode (*Globodera pallida*, *Ditylenchus dipsacci, Ditylenchus destructor* and *Trichodorus viruliferus*). Therefore, these nematode are estimated to present a **High (3)** risk of being moved to a habitat suitable for survival.

In China, *Pseudomonas marginalis* pv. *marginalis* was caused of bacterial soft rot of potato (*Solanum tuberosum*) which grew at temperature range of from 0^0 – 36^0C with optimum temperature of 30^0 – 33^0C (Yong-Ki Kim, Seung-Don Lee, 2002). Therefore, *Pseudomonas marginalis* pv. *marginalis* is assumed to present a **High (3)** risk of being moved to the agriculture ecological zones in Vietnam suitable for survival.

Tomato spotted wilt virus (TSWV), *Tomato black ring virus* (TBRV) and *Alfalfa mosaic virus* (AMV) are some of the important viruses on potatoes in the world. These viruses have a wide hosts range and transmitted via seed. Seed transmission is often regarded as being important in establishing primary infections from which there is secondary transmission by aphid vectors or nematodes (*Longidorus* sp.). In Vietnam, under tropical and sub-tropical conditions suitable for survival. These viruses could become established in all the agriculture ecological zones in Vietnam. Therefore, they are rated to be **High (3)** for risk element.

6. Sub-element 6- Come into contact with host material suitable for reproduction

Because species of Solanaceae (Potato, Tomato, Eggplant…) have distributions in the Northern, Red River Delta and Da Lat of Vietnam (MARD, 2007), suitable host material should be available for all of the pests analyzed. Risk of seed potatoes coming into contact with host material suitable for reproduction therefore is estimated to be **High (3),** except for *Polyscytalum pustulans* which have a limited capacity for natural dispersal, therefore, they are considered to have a **Medium (2)** risk of coming into contact with host material via this pathway. A total of 40-290 eggs of *Phthorimaea operculella* can laid on the leaves of the host plant, that present in all ecological zones in Vietnam. This pest is rated **High (3)** for this risk sub-element.

Delia platura maggot is extremely polyphagous (more than 40 host plants). In Vietnam, this species could become established in many suitable host plants for their reproduction. Therefore, *Delia platura* is estimated to present a **High (3)** risk of being moved to a host suitable for survival. *Melolontha melolontha* may affects plant stages: flowering stage, fruiting stage and vegetative growing stage of different hosts. Therefore, *Melolontha melolontha* is estimated to present a **Medium (2)** risk of being moved to a host suitable for survival.

Potato is a suitable host of *Globodera pallida*, *Ditylenchus dipsacci*, *Ditylenchus destructor* and *Trichodorus viruliferus*. Beside that, many other host plants among families Sonalaceae, Fabaceae, Brassicaceae, Asteraceae etc. (such as tomato, aubergine, onion, garlic, and so on) are also grown popularly in Vietnam. Therefore, they are considered to have a **High (3)** risk of coming into contact with host material via this pathway.

Solanum tuberosum is the major host plant of *Pseudomonas marginalis* pv. *marginalis, P. exigua* var. *foveata, Fusarium sulphureum, Phytophthora drechsleri, Phytophthora megasperma, Synchytrium endobioticum* and *Verticillium albo-atrum*, especially storage potatoes. On the other hand, *Solanum tuberosum* distributed widely in Red River Delta zones (takes approximately 75 percent of winter plants) where there are many other host plants suitable for reproduction of these species. On the other hand, there are many host plants suitable for reproduction such as *Cucumis melo, Cucurbita (pumpkin), Allium cepa*, etc. Risk of these species coming into contact with host material suitable for reproduction therefore are estimated to be **High (3).**

Tomato spotted wilt virus (TSWV), *Tomato black ring virus* (TBRV) and *Alfalfa mosaic virus* (AMV) have a wide host range suitable for reproduction. Natural plant hosts of TBRV, TSWV and AMV include many crop and weed species (Harrison, 1957; 1958b; Smith and Short, 1959; Calvert and Harrison, 1963; Schmelzer, 1963; Hollings, 1965) such as hop, cotton, tomato, lucerne…. The hosts always in Vietnam. They are rated to be **High (3)** for this risk element.

Table 4. Risk Rating for Likelihood of Introduction

Pest	Quantity imported annually	Survive post harvest treatment	Survive shipment	Not detected at port of entry	Moved to suitable habitat	Contact with host material	Cumulative Risk Rating
Delia platura (Meigen) Order: **Diptera** Family: **Anthomyiidae**	Low (1)	Low (1)	High (3)	Medium (2)	Low (1)	High (3)	**Medium (11)**
Melolontha melolontha Linnaeus Order:**Coleoptera** Family: **Scarabaeidae**	Low (1)	Low (1)	High (3)	Low (1)	Medium (2)	Medium (2)	**Medium (10)**
Phthorimaea operculella (Zeller 1873) Order: **Lepidoptera** Family: **Gelechiidae**	Low (1)	High (3)	High (3)	Medium (2)	High (3)	High (3)	**High (15)**
Fusarium sulphureum (Fr.) Sacc Order: **Hypocreales** Family: **Nectriaceae**	Low (1)	Medium (2)	High (3)	Low (1)	High (3)	High (3)	**Medium (13)**
Phoma exigua var. *foveata* (Foister) Order: **Diaporthales** Family: **Valsaceae**	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	**Medium (14)**
Phytophthora drechsleri Tucker Order: **Pythiales** Family: **Pythiaceae**	Low (1)	Medium (2)	High (3)	High (3)	High (3)	High (3)	**High (15)**
Phytophthora megasperma Drechsler Order: **Pythiales** Family: **Pythiaceae**	Low (1)	Medium (2)	High (3)	High (3)	High (3)	High (3)	**High (15)**
Polyscytalum pustulans (M.N. Owen & Makef) M.B. Ellis Order: **Polyporales;** Family: **Meripilaceae**	Low (1)	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	**Medium (13)**

Pest	Quantity imported annually	Survive post harvest treatment	Survive shipment	Not detected at port of entry	Moved to suitable habitat	Contact with host material	Cumulative Risk Rating
Synchytrium endobioticum (Schilb.) Order: **Chytridiales** Family:**Synchytriaceae**	Low (1)	High (3)	High (3)	High (3)	High (3)	High (3)	**High (16)**
Verticillium albo-atrum Reinke& Berthold Order: **Hypocreales** Family: **Hypocreaceae**	Low (1)	High (3)	High (3)	High (3)	High (3)	High (3)	**High (16)**
Ditylenchus destructor Thorne Order: **Tylenchida** Family: **Anguinidae**	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	**Medium (14)**
Ditylenchus dipsaci (Kuehn, 1857) Filipjev Order: **Tylenchida** Family: **Anguinidae**	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	**Medium (14)**
Globodera pallida (Stone, 1973) Behrens Order: **Tylenchida** Family: **Heteroderidae**	Low (1)	High (3)	High (3)	Medium (2)	High (3)	High (3)	**High (15)**
Globodera rostochinensis (Wollenweder) Order: **Tylenchida** Family: **Heteroderidae**	High (3)	High (3)	High (3)	High (3)	High (3)	High (3)	**High (18)**
Trichodorus viruliferus Hooper Order: **Triplonchida** Family: **Trichodoridae**	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	**Medium (14)**
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925 Order: **seudomonadales** Family:**Pseudomonadaceae**	Low (1)	Medium (2)	High (3)	High (3)	High (3)	High (3)	**High (15)**
Alfalfa mosaic virus Family: **Bromoviridae** Genus: **Alfamovirus**	Low (1)	High (3)	High (3)	High (3)	High (3)	High (3)	**High (16)**
Tomato spotted wilt virus (TSWV) Family: **Bunyaviridae** Genus: **Tospovirus**	Low (1)	High (3)	High (3)	High (3)	High (3)	High (3)	**High (16)**
Tomato black ring virus (TBRV) Family: **Bunyaviridae** Genus: **Tospovirus**	Low (1)	High (3)	High (3)	High (3)	High (3)	High (3)	**High (16)**

2.6. Conclusion/Pest Risk Potential: Pests Requiring Phytosanitary Measures

To estimate the Pest Risk Potential for each pest, sum the Cumulative Risk Rating for both Consequences of Introduction and the Cumulative Risk Rating for the Likelihood of Introduction

Rate the Pest Risk Potential as follows:

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

Table 5. Pest Risk Potential

Pest	Consequence of Introduction	Likelyhood of Introduction	Pest Risk Potential
Delia platura (Meigen) Order: **Diptera** Family: **Anthomyiidae**	High (13)	Medium (11)	**Medium (24)**
Melolontha melolontha Linnaeus Order:**Coleoptera** Family: **Scarabaeidae**	Medium (12)	Medium (10)	**Medium (22)**
Phthorimaea operculella (Zeller 1873) Order: **Lepidoptera** Family: **Gelechiidae**	High (14)	High (15)	**High (29)**
Fusarium sulphureum (Fr.) Sacc Order: **Hypocreales** Family: **Nectriaceae**	High (14)	Medium (13)	**High (27)**
Phoma exigua var. *foveata* (Foister) Order: **Diaporthales** Family: **Valsaceae**	Medium (11)	Medium (14)	**Medium (25)**
Phytophthora drechsleri Tucker Order: **Pythiales** Family: **Pythiaceae**	High (14)	High (15)	**High (29)**
Phytophthora megasperma Drechsler Order: **Pythiales** Family: **Pythiaceae**	Medium (12)	High (15)	**High (27)**
Polyscytalum pustulans (M.N. Owen & Makef) M.B. Ellis Order: **Polyporales** Family: **Meripilaceae**	Medium (9)	Medium (13)	**Medium (22)**
Synchytrium endobioticum (Schilb.) Order: **Chytridiales** Family:**Synchytriaceae**	Medium (14)	High (16)	**High (30)**
Verticillium albo-atrum Reinke& Berthold Order: **Hypocreales** Family: **Hypocreaceae**	High (14)	High (16)	**High (30)**
Ditylenchus destructor Thorne Order: **Tylenchida** Family: **Anguinidae**	High (14)	Medium (14)	**High (28)**

Pest	Consequence of Introduction	Likelyhood of Introduction	Pest Risk Potential
Ditylenchus dipsaci (Kuehn, 1857) Filipjev Order: **Tylenchida** Family: **Anguinidae**	High (14)	Medium (14)	**High** **(28)**
Globodera pallida (Stone, 1973) Behrens Order: **Triplonchida** Family: **Heteroderidae**	High (13)	Medium (14)	**High** **(27)**
Globodera rostochinensis (Wollenweder) Order: **Tylenchida** Family: **Heteroderidae**	High (14)	High (18)	**High** **(32)**
Trichodorus viruliferus Hooper Order: **Triplonchida** Family: **Trichodoridae**	Medium (10)	Medium (14)	**Medium** **(24)**
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925 Order: **Pseudomonadales** Family:**Pseudomonadaceae**	High (14)	High (15)	**High** **(29)**
Alfalfa mosaic virus (AMV) Family: **Bromoviridae** Genus: **Alfamovirus**	High (13)	High (16)	**High** **(29)**
Tomato black ring virus (TBRV) Family: **Bunyaviridae** Genus: **Tospovirus**	Medium (12)	High (16)	**High** **(28)**

Potential ratings:
- Low: Pest will typically not require specific mitigations measures;
- Medium: Specific phytosanitary measure may be necessary.
- High: Specific phytosanitary measures are strongly recommended. Port-of-entry inspection is not considered sufficient to provide phytosanitary security.

Identification and selection of appropriate sanitary and phytosanitary measures to mitigate risk for pests with particular Pest Risk Potential ratings is undertaken as part of the risk management phase and is not discussed in this document.

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PEST RISK MANAGEMENT

1. Outline

According to the proposal of Scottish Agricultural Science Agency (SASA) for exporting seed Potatoes to Vietnam, Plant Protection Department (PPD), Ministry of Agriculture and Rural Development conducted a pathway-initiated risk assessment to determine the unmitigated risks associated with importing seed Potatoes from Scotland. In conducting the assessment, the analysts first prepared a list of pests from Scotland associated with *Solanum tuberosum* based on (1) documents submitted by Scottish Agricultural Science Agency (SASA), (2) PPD records of intercepted pests, and (3) scientific literature.

From this list, the analysts then determined which quarantine pests (identified to the species level) are likely to follow the seed Potatoes pathway and qualitatively analyzed them to determine the unmitigated risk each poses to Vietnam. The following pests were identified as having high and medium unmitigated risk potential:

There are 13 pests with **High** risk rate:

Phthorimaea operculella (Zeller 1873)
Fusarium sulphureum (Fr.) Sacc
Phytophthora megasperma Drechsler
Phytophthora drechsleri Tucker
Synchytrium endobioticum (Schilb.) Percival
Verticillium albo-atrum Reinke & Berthold
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925
Ditylenchus destructor Thorne, 1945
Ditylenchus dipsaci (Kuchn, 1857) Filijev, 1936
Globodera pallida (Stone, 1973) Behrens 1975
Globodera rostochinensis (Wollenweder)
Alfalfa Mosaic Virus (AMV)
Tomato Black Ring Virus (TBRV)

There are 5 pests with **Medium** risk rate:

Delia platura Meigen
Melolontha melolontha Linnaneus
Phoma foveata Foister
Polyscytalum pustulans (M.N. Owen & Makef) M.B. Ellis
Trichodorus viruliferus Hooper, 1963

2. Management Measures

2.1. Management measures for pests with high risk rate:

- Requirement of Pest-Free Areas

A pest-free area (PFA) is defined as “an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained” (IPPC, 1996b, 2006). As a sole mitigation measure, the establishment of pest-free areas or pest-free places of production may be completely effective in satisfying an importing country’s appropriate level of phytosanitary protection (IPPC, 1996b, 1999).

Establishment and maintenance of pest-free areas or production sites should be in compliance with international standards (*e.g.*, IPPC, 1996b, 1999, 2006).

Potatoes grown in an area that has not been determined to be free of high risk pests would be required to be grown in approved production sites registered with the National Plant Protection Organization (NPPO) of Scotland. Initial approval of the production sites would be completed jointly by the Scottish NPPO and Plant Protection Department (PPD).

These standards specify the appropriate steps for establishment, maintenance, verification, changes in status, an emergency action plan, reinstatement of status, documentation, and bilateral work plans for high risk pests PFA.

The objective of this risk management measure is to ensure that seed potatoes exported to Vietnam from Scotland is not infested with 12 high risk pests including the below pests:

Fusarium sulphureum (Fr.) Sacc
Phytophthora megasperma Drechsler
Phytophthora drechsleri Tucker
Synchytrium endobioticum (Schilb.) Percival
Verticillium albo-atrum Reinke & Berthold
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925
Ditylenchus destructor Thorne, 1945
Ditylenchus dipsaci (Kuchn, 1857) Filijev, 1936
Globodera pallida (Stone, 1973) Behrens 1975
Globodera rostochinensis (Wollenweder)
Alfalfa Mosaic Virus (AMV)
Tomato Black Ring Virus (TBRV)

- Pre-clearance Inspection

According to Item 8, Article 5, chapter I of Decree on Plant Quarantine of Vietnam number 02/2007/ND-CP dated Jan 07th, 2007 of the Government of Vietnam: "Quarantine inspectors of Scottish and Vietnam can do together on field surveillance and ….”; therefore NPPOs of Scottish and Vietnam shall carry out pests surveillance in potato production areas in Scottish for confirmation of status of Pest-Free Area for 12 high risk pests as:

Fusarium sulphureum (Fr.) Sacc
Phytophthora megasperma Drechsler
Phytophthora drechsleri Tucker
Synchytrium endobioticum (Schilb.) Percival
Verticillium albo-atrum Reinke & Berthold
Pseudomonas marginalis pv. marginalis (Brown 1918) Stevens 1925
Ditylenchus destructor Thorne, 1945
Ditylenchus dipsaci (Kuchn, 1857) Filijev, 1936
Globodera pallida (Stone, 1973) Behrens 1975
Globodera rostochinensis (Wollenweder)
Alfalfa Mosaic Virus (AMV)
Tomato Black Ring Virus (TBRV)

The suitable time for pests surveillance is about 30 days after growing.

- Pre-export Inspection and Treatment

Scotland's NPPO will inspect all consignments in accordance with official procedures in order to confirm those consignments are satisfied with phytosanitary import requirements of Vietnam.

If a plant quarantine insect *Phthorimaea operculella* Zeller is found during inspection, the consignment may be treated by Methyl bromide (100% CH_3Br) fumigation at 40g/m^3 in 3 hours (Plant Quarantine Diagnostic Centre, PPD of Vietnam, 2003). Beside, at 21 - 25^oC temperature, this insect can be treated by methyl bromide fumigation at 15-18g/m^3 in 5 - 6 hours (EPPO, 1998, www.eppo.org/Meetings/2006_meetings/treatments.htm).

The Scotland NPPO will issue a phytosanitary certificate for each consignment after completion of the pre-export phytosanitary inspection consistent with International Standards for Phytosanitary Measures No. 7 *Export Certification Systems* (FAO, 2006). The objective of this procedure is to provide formal documentation to PPD verifying that the relevant measures have been undertaken offshore.

2.2. Management measure for pests with medium risk rate:

- Low Pest Prevalence Area

Area of low pest prevalence is an area, whether all of a country, part of a country, or all or parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (IPPC, 1999).

Any protocol for establishing and maintaining an area of low pest prevalence also should include a pest-reporting procedure and emergency action plan to address target pest detections in the pest-free or low-prevalence zones (IPPC, 1999, 2005a).

This option is applied to pests which rated Medium risk including the below pests:

Delia platura Meigen
Melolontha melolontha Linnaneus
Phoma foveata Foister
Polyscytalum pustulans (M.N. Owen & Makef) M.B. Ellis
Trichodorus viruliferus Hooper, 1963

For pest species rated at the medium risk apply measures to minimize risk as follows

- Field
  Variety grown - some are more resistant than others
  Sow at a time to harvest before pests are economic - pest avoidance
  Pest control mehtods - reduce pest level
- Harvest
  Harvest when pests are not present, or when at low level - pest monitoring required
  Select only healthy plants
  Isolate harvested material to avoid re-infection
- Grading
  Acceps only unsymptom/unblemished product
  Remove any infected material
  Clean commodity before packing - brushing, waxing etc
- Packing

Identify individual producers on the packs - grower registration
Isolate packing area to avoid re-infestation
Isolate commodity after packing to avoid re-infestation - cool rooms

- Treatment
  Treatments to be conducted in accordance with importers requirements
  Specified treatment of the consignment - such treatments are applied post-harvest and could include chemical, thermal, irradiation or other physical methods
  Dispactch or storage to avoid re-infestation
  Certificatio of treatment on PC or inspection for free this pests
- Entry inspection
  Inspection to level trquired to detec pest to required confidence limits
  Audit of documentation
  Feedback in case of non-compliance

Combined with inspection, effective integrated pest management (IPM) programs would be a possible mitigation option.

- Pre-export Inspection and Treatment

Scottish NPPO will inspect all consignments in accordance with official procedures in order to confirm those consignments are satisfied with import requirements on phytosanitary of Vietnam.

If quarantine pests which are insect pests (*Delia platura* or *Melolontha melolontha or Phthorimaea operculella* or all) are found during inspection, the consignment may be treated by methyl bromide $48g/m^3/2$ hours (100% CH_3Br).

In case of other quarantine pests (*Fusarium sulphureum, Phytophthora megasperma, Phytophthora drechsleri, Synchytrium endobioticum, Verticillium albo-atrum, Phoma foveata, Polyscytalum pustulans, Pseudomonas marginalis pv. Marginalis, Ditylenchus destructor, Ditylenchus dipsaci, Globodera pallida, Globodera rostochinensis, Trichodorus viruliferus, Alfalfa Mosaic Virus (AMV), Tomato Black Ring Virus* (TBRV) are found during inspection, the consignment should not be exported to Vietnam.

- Inspection and Treatment at Port of Entry

Upon arrival in the Vietnam, each consignment should be inspected to detect pests, with export phytosanitary certificate and seed certificate. In the case, *Delia platura*, *Melolontha melolontha*, *Phthorimaea operculella* insects are found in the consignment, PPD will be given the option to treat (if a suitable treatment is available): fumigation by Pure Methyl Bromide at $48g/m^3$ in 2 hours.

The consignment could re-export or destroy if quarantine pests or regulated articles (*Fusarium sulphureum, Phytophthora megasperma, Phytophthora drechsleri, Synchytrium endobioticum, Verticillium albo-atrum, Phoma foveata, Polyscytalum pustulans, Pseudomonas marginalis pv. Marginalis, Ditylenchus destructor, Ditylenchus dipsaci, Globodera pallida, Globodera rostochinensis, Trichodorus viruliferus, Alfalfa Mosaic Virus (AMV), Tomato Black Ring Virus* (TBRV) are found during an inspection.

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