



Procedural Standard for Pest Risk Analysis (PRA) in Bhutan

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1. Introduction

This document outlines the standards for carrying out Pest Risk Analysis (PRA) for quarantine pests in Bhutan. The standard details the decision process or path by which the risk(s) presented by a commodity or identified quarantine pest(s) is assessed and managed by the Bhutan Agriculture and Food Regulatory Authority (BAFRA).

1.1 References

1.1.1 International Plant Protection Convention (IPPC) Standards related to Pest Risk Analysis

The decision processes outlined in this standard are aligned directly with the International Standards for Phytosanitary Measures (ISPMs) as follows:

- ISPM No. 2-*Framework for pest risk analysis*: This standard describes the overall process of PRA for pests of plants.
- ISPM No. 3 - *Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms*: This standard provides guidelines for risk management related to the export, shipment, import and release of biological control agents and other beneficial organisms, and contains a section on PRA for these types of organisms.
- ISPM No. 11 - *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms*: This standard describes the factors to consider when conducting a PRA to determine if a pest is a quarantine pest. The emphasis in ISPM No. 11 is on the pest risk assessment and risk management components of PRA, although the full PRA process is covered.
- ISPM No. 21 - *Pest risk analysis for regulated non-quarantine pests*: This standard provides guidelines for conducting PRA on regulated non-quarantine pests.
- *Other ISPMs applicable to PRA*:
 - * ISPM No. 1 -*Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade*: This standard describes the principles of plant quarantine as related to international trade.
 - * ISPM No. 5 -*Glossary of phytosanitary terms*: This standard is a glossary of terms and definitions applicable to phytosanitary systems worldwide. It provides an internationally agreed-upon vocabulary associated with the IPPC and ISPMs.
 - * ISPM No. 5, Supplement No. 1 -*Guidelines on the interpretation and application of the concept of official control for regulated pests*: This supplement describes the concept of official control of regulated pests and its application.
 - * ISPM No. 5, Supplement No. 2 - *Guidelines on the understanding of potential economic importance and related terms including reference to environmental considerations*: This supplement provides background and other relevant information to clarify potential economic importance and related terms so that their application is consistent with the IPPC.
 - * ISPM No. 6 - *Guidelines for surveillance*: This standard describes the components of survey and monitoring systems for the purpose of pest detection and the supply of information for use in PRAs, the establishment of pest free areas and, where appropriate, the preparation of pest lists.
 - * ISPM No. 8 -*Determination of pest status in an area*: This standard describes the content of a pest record, and the use of pest records and other information in the determination of pest status in an area.

- * ISPM No. 14 - *The use of integrated measures in a systems approach for pest risk management*: This standard describes how a systems approach to pest risk management can meet phytosanitary import requirements.
- * ISPM No. 17 - *Pest reporting*: This standard describes the responsibilities of, and requirements for, contracting parties in reporting the occurrence, outbreak and spread of pests in areas for which they are responsible. It also provides guidance on reporting successful eradication of pests and establishment of pest free areas.
- * ISPM No. 19 - *Guidelines on lists of regulated pests*: This standard describes the procedure to prepare, maintain, and make available lists of regulated pests.
- * ISPM No. 24 - *Guidelines for the determination and recognition of equivalence of phytosanitary measures*: This standard describes the principles and requirements that apply for the determination and recognition of equivalence of phytosanitary measures. It also describes a procedure determining equivalence in international trade.

The user is encouraged to refer to the current versions of ISPMs at: <https://www.ippc.int>

The current version is a combination of the draft prepared by Warren Philip (FAO Consultant) for Bhutan and other PRA standards including the European Plant Protection Organisation (EPPO), Animal and Plant Health Service (APHIS) of the United States, Biosecurity Import Risk Analysis Guidelines 2016 of Australia, and the Caribbean Agricultural Health and food Safety Agency in addition to guidelines and procedures provided in ISPM 2 and ISPM 11. Many sections are presented verbatim as in these resources.

1.1.2 National legislations

The following national legislations and regulations facilitate the implementation of PRA in the country:

- a. The Plant Quarantine Act of Bhutan 1993
- b. The Seed Act of Bhutan 2000
- c. The Biodiversity Act of Bhutan 2003
- d. The Forest and Nature Conservation Act of Bhutan 1995
- e. Plant Quarantine Rules and Regulations 2018
- f. Seed Rules and Regulations of Bhutan 2018

1.2 Definitions and abbreviations

Comprehensive list of phytosanitary terms can be found in ISPM No. 5 (IPPC Glossary). Key terms used in this standard are taken from ISPM 5 (FAO, 2019).

** Indicates that the term, at the time of publishing, is on the work programme of the Technical Panel for the Glossary which means the terms or definitions may be revised or deleted in the future.*

Additional declaration A statement that is required by an importing country to be entered on a **phytosanitary certificate** and which provides specific additional information on a **consignment** in relation to **regulated pests** or **regulated articles** [FAO, 1990; revised ICPM, 2005; CPM, 2016]

Area An **officially** defined country, part of a country or all or parts of several countries [FAO, 1990; revised ISPM 2, 1995; CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (WTO, 1994)]

Area of low pest prevalence	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 is present at low levels and which is subject to effective surveillance or control measures [IPPC, 1997; revised CPM, 2015]
Bulbs and tubers (as a commodity class)*	Dormant underground parts of plants intended for planting (includes corms and rhizomes) [FAO, 1990; revised ICPM, 2001]
Commodity *	A type of plant , plant product , or other article being moved for trade or other purpose [FAO, 1990; revised ICPM, 2001]
Commodity pest list	A list of pests present in an area which may be associated with a specific commodity [CEPM, 1996; revised CPM, 2015]
Consignment	A quantity of plants , plant products or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) [FAO, 1990; revised ICPM, 2001]
Containment	Application of phytosanitary measures in and around an infested area to prevent spread of a pest [FAO, 1995]
Contaminating pest	A pest that is carried by a commodity , packaging , conveyance or container, or present in a storage place and that, in the case of plants and plant products , does not infest them [CEPM, 1996; revised CEPM, 1999; CPM, 2018]
Control (of a pest)	Suppression , containment or eradication of a pest population [FAO, 1995]
Country of origin (of a consignment of plant products)	Country where the plants from which the plant products are derived were grown [FAO, 1990; revised CEPM, 1996; CEPM, 1999]
Country of origin (of a consignment of plants)	Country where the plants were grown [FAO, 1990; revised CEPM, 1996; CEPM, 1999]
Country of origin (of regulated articles other than plants and plant products)	Country where the regulated articles were first exposed to contamination by pests [FAO, 1990; revised CEPM, 1996; CEPM, 1999]
Delimiting survey	Survey conducted to establish the boundaries of an area considered to be infested by or free from a pest [FAO, 1990; revised FAO, 1995]
Detection survey *	Survey conducted in an area to determine if pests are present [FAO, 1990; revised FAO, 1995]
Detention	Keeping a consignment in official custody or confinement, as a phytosanitary measure [FAO, 1990; revised FAO, 1995; CEPM, 1999; ICPM, 2005]

Ecosystem	A dynamic complex of plant , animal and micro-organism communities and their abiotic environment interacting as a functional unit [ISPM 3, 1995; revised ICPM, 2005]
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss [ISPM 2, 1995]
Entry (of a consignment)	Movement through a point of entry into an area [FAO, 1995]
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled [ISPM 2, 1995]
Eradication	Application of phytosanitary measures to eliminate a pest from an area [FAO, 1990; revised FAO, 1995; formerly“eradicate”]
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry [FAO, 1990; revised ISPM 2, 1995; IPPC, 1997; formerly“established”]
Exclusion (of a pest)	Application of phytosanitary measures to prevent the entry or establishment of a pest into an area [CPM, 2018]
Field	A plot of land with defined boundaries within a place of production on which a commodity is grown [FAO, 1990]
Find free	To inspect a consignment , field or place of production and consider it to be free from a specific pest [FAO, 1990]
Free from (of a consignment, field or place of production)	Without pests (or a specific pest) in numbers or quantities that can be detected by the application of phytosanitary procedures [FAO, 1990; revised FAO, 1995; CEPM, 1999]
Habitat	Part of an ecosystem with conditions in which an organism is naturally present or can establish [ICPM, 2005; revised CPM, 2015]
Host pest list	A list of pests that infest a plant species, globally or in an area [CEPM, 1996; revised CEPM, 1999]
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism [FAO, 1990; revised ISPM 3, 2005]
Import permit	Official document authorizing importation of a commodity in accordance with specified phytosanitary import requirements [FAO, 1990; revised FAO, 1995; ICPM, 2005]
Incursion	An isolated population of a pest recently detected in an area , not known to be established , but expected to survive for the immediate future [ICPM, 2003]
Infestation (of a	Presence in a commodity of a living pest of the plant or plant

commodity)	product concerned. Infestation includes infection [CEPM, 1997; revised CEPM, 1999]
Inspection*	Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations [FAO, 1990; revised FAO, 1995; formerly “inspect”]
Integrity (of a consignment)*	Composition of a consignment as described by its phytosanitary certificate or other officially acceptable document, maintained without loss, addition or substitution [CPM, 2007]
Intended use	Declared purpose for which plants, plant products or other articles are imported, produced or used [ISPM 16, 2002; revised CPM, 2009]
Interception (of a consignment)	The refusal or controlled entry of an imported consignment due to failure to comply with phytosanitary regulations [FAO, 1990; revised FAO, 1995]
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment [FAO, 1990; revised CEPM, 1996]
International Plant Protection Convention (IPPC)	International Plant Protection Convention , as deposited with FAO in Rome in 1951 and as subsequently amended [FAO, 1990]
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of FAO, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPPC [CEPM, 1996; revised CEPM, 1999]
International standards	International standards established in accordance with Article X paragraphs 1 and 2 of the IPPC [IPPC, 1997]
Introduction (of a pest)	The entry of a pest resulting in its establishment [FAO, 1990; revised ISPM 2, 1995; IPPC, 1997]
Living modified organism (LMO)	Any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology [Cartagena Protocol on Biosafety to the Convention on Biological Diversity (CBD, 2000)]
Natural enemy	An organism which lives at the expense of another organism in its area of origin and which may help to limit the population of that organism. This includes parasitoids, parasites, predators , phytophagous organisms and pathogens [ISPM 3, 1995; revised ISPM 3, 2005]
Non-quarantine pest	Pest that is not a quarantine pest for an area [FAO, 1995]
NPPO Official	National plant protection organization [FAO, 1990; ICPM, 2001] Established, authorized or performed by a national plant protection organization [FAO, 1990]
Official control	The active enforcement of mandatory phytosanitary regulations

	and application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests of for the management of regulated non-quarantine pests [ICPM, 2001]
Pathway	Any means that allows the entry or spread of a pest [FAO, 1990; revised FAO, 1995]
Pest	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products . Note: In the IPPC, “plant pest” is sometimes used for the term “pest” [FAO, 1990; revised ISPM 2, 1995; IPPC, 1997; CPM, 2012]
Pest categorization	The process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest [ISPM 11, 2001]
Pest free area	An area in which a specific pest is absent as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained [ISPM 2, 1995; revised CPM, 2015]
Pest record	A document providing information concerning the presence or absence of a specific pest at a particular location at a certain time, within an area (usually a country) under described circumstances [CEPM, 1997]
Pest risk (for quarantine pests)	The probability of introduction and spread of a pest and the magnitude of the associated potential economic consequences [ISPM 2, 2007]
Pest risk (for regulated non-quarantine pests)	The probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact [ISPM 2, 2007]
Pest risk analysis (agreed interpretation)	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest , whether it should be regulated, and the strength of any phytosanitary measures to be taken against it [ISPM 2, 1995; revised IPPC, 1997; ISPM 2, 2007]
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area , including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information [CEPM, 1997; revised ICPM, 1998]
Phytosanitary certificate	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC , attesting that a consignment meets phytosanitary import requirements [FAO, 1990; revised CPM, 2012]
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate [FAO, 1990]
Phytosanitary import requirements	Specific phytosanitary measures established by an importing country concerning consignments moving into that country [ICPM, 2005]

Phytosanitary legislation	Basic laws granting legal authority to a national plant protection organization from which phytosanitary regulations may be drafted [FAO, 1990; revised FAO, 1995]
Phytosanitary measure (agreed interpretation)	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests , or to limit the economic impact of regulated non-quarantine pests [ISPM 4, 1995; revised IPPC, 1997; ICPM, 2002]
<i>The agreed interpretation of the term phytosanitary measure accounts for the relationship of phytosanitary measures to regulated non-quarantine pests. This relationship is not adequately reflected in the definition found in Article II of the IPPC (1997).</i>	
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests [FAO, 1990; revised FAO, 1995; CEPM, 1999; ICPM, 2001; ICPM, 2005]
Phytosanitary regulation	Official rule to prevent the introduction or spread of quarantine pests , or to limit the economic impact of regulated non-quarantine pests , including establishment of procedures for phytosanitary certification [FAO, 1990; revised ISPM 4, 1995; CEPM, 1999; ICPM, 2001]
Plant products	Unmanufactured material of plant origin (including grain) and those manufactured products that, by their nature or that of their processing, may create a risk for the introduction and spread of pests [FAO, 1990; revised IPPC, 1997; formerly “plant product”]
Plant quarantine	All activities designed to prevent the introduction or spread of quarantine pests or to ensure their official control [FAO, 1990; revised FAO, 1995]
Point of entry	Airport, seaport, land border point or any other location officially designated for the importation of consignments , or the entrance of persons [FAO, 1995; revised CPM, 2015]
PRA area	Area in relation to which a pest risk analysis is conducted [ISPM 2, 1995]
Prohibition	A phytosanitary regulation forbidding the importation or movement of specified pests or commodities [FAO, 1990; revised FAO, 1995]
Provisional measure	A phytosanitary regulation or procedure established without full technical justification owing to current lack of adequate information. A provisional measure is subjected to periodic review and full technical justification as soon as possible [ICPM, 2001]
Quarantine	Official confinement of regulate articles, pests or beneficial organisms for inspection, testing, treatment , observation or research [FAO, 1990; revised ISPM 3, 1995; CEPM, 1999; CPM,

	2018]
Quarantine area*	An area within which a quarantine pest is present and is being officially controlled [FAO, 1990; revised FAO, 1995]
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled [FAO, 1990; revised FAO, 1995; IPPC1997]
Reference specimen	Specimen, from a population of a specific organism, conserved and accessible for the purpose of identification, verification or comparison.[ISPM 3, 2005; revised CPM, 2009]
Regional Plant Protection Organization	An intergovernmental organization with the functions laid down by Article IX of the IPPC [FAO, 1990; revised FAO, 1995; CEPM, 1999;formerly “plant protection organization (regional)”]
Regulated area	An area into which, within which or from which plants, plant products and other regulated articles are subjected to phytosanitary measures [CEPM, 1996; revised CEPM, 1999; ICPM, 2001]
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affectsthe intended use of those plants with an economically unacceptableimpact and which is therefore regulated within the territory of the importing contracting party [IPPC, 1997]
Regulated pest	Quarantine pest or a regulated non-quarantine pest [IPPC, 1997]
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area [ISPM 2, 1995]
Standard	Document established by consensus and approved by a recognized body that provides for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement ofthe optimum degree of order in a given context [FAO, 1995; ISO/IEC Guide 2:1991 definition]
Surveillance	An official process which collects and records data on pest presence orabsence by survey, monitoring or other procedures [CEPM, 1996; revised CPM, 2015]
Transience	Presence of a pest that is not expected to lead to establishment [ISPM 8,1998]
Treatment*	Official procedure for the killing, inactivation or removal of pests , orfor rendering pests infertile or for devitalization [FAO, 1990, revised FAO, 1995; ISPM 15, 2002; ISPM 18, 2003; ICPM, 2005]

2. Pest Risk Assessment (PRA)

PRA is defined as: ‘The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a **pest**, whether it should be regulated, and the strength of any **phytosanitary measures** to be taken against it [ISPM 2, 1995; revised IPPC, 1997; ISPM 2, 2007]’.

An organism may be a quarantine pest and regulated or a non-quarantine pest or regulated non-quarantine pest. Pest risk assessment allows categorisation of a pest and determine the risk associated with it, and the phytosanitary measures, if any, should be taken to reduce the risk. If a pest is determined as a quarantine pest, the probability of entry, establishment, spread and the potential consequences is assessed based on scientific, technical and economic evidences. If risk is at an unacceptable level then assessment is further conducted to suggest risk management options. Thus, PRA consist of three stages:

Stage 1: Initiating the process

Stage 2: Pest categorisation and risk assessment

Stage 3: Risk management

Pest risk is estimated qualitatively based on its likelihood of entry, establishment and spread, and the consequences. To assess each of these stages, a series of criteria are considered for assessing the likelihood of pest risk. Overall risk of each pest is estimated based on the combined likelihood of entry, establishment and spread, and consequences. To conduct PRA, follow each step of the three stages described in the following sections.

2.1 Stage 1: Initiation

The aim of the initiation stage is to identify the pest(s) and pathways which are of phytosanitary concern and should be considered for risk analysis in relation to the identified PRA area. State the reason for performing the PRA (refer below).

The PRA may be initiated for one or several reasons, hence the initiation stage should comprise of information gathering and documentation. The most common reasons for PRA are:

PRA initiated by the identification of a pathway

- international trade is initiated in a commodity not previously imported into the country, or a commodity from a new area or new country of origin
- new plant species are imported for breeding or research purposes
- a pathway other than a commodity import is identified (natural spread, packing material, mail, e-commerce, garbage, passenger baggage, wood and wood products, soil/growing medium)

In such cases, a list of pests likely to be associated with the pathway should be generated and preferably prioritized based on pest distribution, pest status and expert judgment.

PRA initiated by the identification of a pest

- an established infestation or an incursion of a pest has been discovered in the PRA area
- a pest has been detected in an imported consignment
- a pest has been identified as a risk by scientific research
- a pest has invaded a new area, other than the PRA area
- a pest is reported to be more damaging in a new area than its area of origin
- a pest is observed to be detected more frequently in international trade
- a request is made for the intentional import of a pest e.g., by educators, researchers, businesses, food industry
- a previous PRA is being re-evaluated
- an organism has been identified as a vector for other pests

In some cases, a PRA may be initiated as above by an organism which is not known to be a pest, but whose pest potential in the PRA area needs to be evaluated.

PRA initiated by the review or revision of a policy

- phytosanitary regulations are being revised, e.g., following a national decision or new information on treatments or processes
- a proposal made by another country or by an international organization (RPPO, FAO) is assessed
- a dispute arises on phytosanitary measures

2.1.1 Decision steps involved in PRA Stage 1

PRA Objectives

Step 1. State whether the PRA team leader and/or BAFRA has received ‘PRA request form’(Appendix 1) compiled by the PRA review officer based on information submitted by the client?

Yes – incorporate the reasons in the form (Appendix 1) and go to Step 2

No – do not proceed until PRA team leader confirms receipt of the form

Step 2. Has the PRA form been cross checked by the PRA team leader for all necessary information?

Yes – Go to Step 3

No – return the form to the PRA review officer for satisfactory completion of information requirements. PRA review officer must collect and cross check all necessary information from the client/applicant. Resume once the completed form is returned.

Step 3. What is the type of PRA trigger?

Specify whether *pest specific OR pathway specific OR review or revision of a policy*, and include in the PRA report

Go to Step 4

Step 4. Specify the pest (pest specific) or pests (pathway specific) of concern by compiling a potential list of pests. For intentionally introduced plants, records of pests associated with the pathway is obtained from the exporting country. Prepare a potential quarantine list of pests (**Table 1**) using the pest information from the

exporting country (**Appendix 2**) and other resources e.g., CABI, national database, published and unpublished reports, expert judgement.

Note: It is an obligation under the IPPC to provide official information regarding pest status of a country, therefore both importing and exporting countries are under this obligation.

If no pest of concern has been identified, end the PRA process here and present the results in the PRA report.

If pest(s) identified, – Go to Step 5

Table 1. Potential quarantine pests associated with the commodity

Type	Preferred scientific name	Preferred common name	Plant parts affected	Present or absent in the exporting country	Present or absent in the importing country	Included in the pathway	Reference
Arthropods Fungi Bacteria Weeds/invasive plants etc.							e.g., CABI datasheet (provide full citation)

Alternately, if one has a CABI account, a pest list can be generated from CABI PRA page. The CABI pest list provides information on whether a pest associated with the commodity is present or absent in both the exporting and importing country. This list is, however, subject to review by the PRA team and the pest categorisation may not necessarily be the same as generated by CABI, especially if information in CABI has not been updated and the status of the pest status/ records have changed in the exporting and importing country.

Step 5. Clearly define the PRA area- *the PRA area can be a complete country, several countries or part(s) of one or several countries.*

Go to Step 6

Step 6. Does a relevant earlier PRA exist?

Yes – Go to Step 7

No – Go to Step 8

Step 7. Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)?

If entirely valid – end PRA here

If partly valid proceed with the PRA, but compare as much as possible with the earlier PRA – Goto 8

If not valid – Goto 8 after concluding the initiation stage

Conclusion of the initiation stage

The following information should be completed:

- a. The reason for conducting the PRA

- b. Information from the exporting country with regards to the commodity involved, industry details, records of pests and existing pest management practices
- c. List of potential quarantine pests
- d. Identification of PRA area

2.2 Stage 2: Pest risk assessment

2.2.1 Pest categorisation

Identify the potential quarantine pest

Use the potential quarantine pest list generated in Step 4 to categorise the pest(s). Perform the steps for each pest as follows.

Step 8. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?

If yes – indicate correct scientific name and taxonomic position, and go to Step 10

If no – Go to Step 9

Step 9. Even if the causalagent of particular symptoms has not yet been fully identified, has it been shown to produce consistent symptoms and to be transmissible?

Yes – Go to 10

No – Go to 19

Determine whether the organism is a pest

Step 10. Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?

Yes, the organism is considered a pest – Go to Step 12

No – Go to Step 11

Step 11. Does the organism have intrinsic attributes that indicate that it could cause significant harm to plants?

Yes or uncertain, the organism may become a pest of plants in the PRA area – Go to Step 12

No – Go to Step 19

Presence or absence of pest in the PRA area and regulatory status (pest status)

Step 12. Does the pest occur in the PRA area? (Pest list generated by CABI indicates the presence or absence of the pest in the importing and exporting country; Check national pest database or other resources in addition to the information retrieved from CABI for confirmation of the presence of the pest in the importing country)

Yes – Go to Step 13

No – Go to Step 14

Step 13. Is the pest widely distributed in the PRA area?

Yes – Go to Step 19

No – Go to Step 14

Potential for establishment and spread of each potential quarantine pest in the PRA area

‘For a pest to establish, it should find host plants or suitable habitat in the PRA area. Natural hosts should be of primary concern but, if such information is lacking, plants which are recorded as hosts only under experimental conditions or accidental/very occasional hosts may also be considered. The pest should also find environmental conditions suitable for its survival, multiplication and spread, either in natural or in protected conditions’.

Step 14. Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non-parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)?

Yes – Go to Step 15 (Prepare a host list and record in the PRA report and cite references)

No – Go to Step 19

Step 15. If a vector is the only means by which the pest can spread, *is a vector present in the PRA area? (If a vector is not needed or is not the only means by which the pest can spread– Go to Step 16).*

Yes – Go to Step 16 (list the vector(s) in the PRA report and cite references)

No – Goto Step 19

Step 16. Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes – Goto Step 17

No – Go to Step 19

Potential for economic consequences of each potential quarantine pest in PRA area

There should be clear indications that the pest is likely to have an **unacceptable economic impact** in the PRA area. Unacceptable economic impact is described in ISPM No. 5 Glossary of phytosanitary terms, Supplement No. 2: Guidelines on the understanding of potential economic importance and related terms. Climatic and cultural conditions in the PRA area should be considered to decide whether important economic (including environmental or social) damage or loss to plants may occur in the PRA area. In some cases, the pest may only be potentially harmful, as suggested by its intrinsic attributes.

Step 17. With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts (e.g., on the environment, on society, on export markets) through the effect on plant health in the PRA area?

Yes OR uncertain – Go to Step 18

No – Go to Step 19

Conclusion of pest categorisation

Step 18. This pest could present a risk to the PRA area.

Go to result compilation of pest categorization & Proceed to Section 2.2.2

Step 19. The pest does not qualify as a quarantine pest for the PRA area and the assessment for this pest can stop.

Stop PRA here and compile the results

Result compilation of pest categorisation in the PRA report

- a. For pathway analysis, follow Steps 6 to 19 for the next pest in Table 1 and finalise the pest categorisation in Table 2.
- b. Pests categorised as quarantine pests in Table 2 would be assessed further: **Go to Section 2.2.2**
- c. If no pests are identified as quarantine pests, summarize the findings of the PRA and furnish PRA report as to how the assessment arrived at the decision in Step 19.

(Note: In some instances, a pest should not be immediately classified as a non-quarantine pest if its life cycle strategy is highly conducive to long term dormancy or have resistant resting spore structures. Such structures if gaining entry to a PRA area could remain viable for many years and/or decades even if its primary or alternative hosts were not present at the time of introduction nor for the foreseeable future, hence cross check and consider all aspects of the pest before categorising the pest as 'no concern').

However, it may be necessary to assess if the pest qualifies as a regulated non-quarantine pest. Refer ISPM No. 21- Pest risk analysis for regulated non-quarantine pests.

Table 2. Categorization of pests associated with commodity (indicate the commodity type e.g., apple) imported from - (name of exporting country).

Pest: (Scientific name)	Present in importing country	Potential for introduction & spread	Potential for economic impact	Quarantine pest
Arthropods Bacteria Fungi Viruses & viroids Weeds/invasive plants Others ; Scientific name	Yes/No (Step 12) Cross check pest database of the importing country against information obtained from the exporting country and other resources. Expert knowledge or judgment can be used for pests that are not updated in the database but are known to occur or not known.	Yes/No (Steps 14-16)	Yes/No (Step 17)	Yes/No (Steps 18-19)

2.2.2 Risk assessment: probability of introduction and spread, and potential economic consequences

This part of the risk assessment firstly estimates the probability of the pest being introduced (i.e., its entry and establishment) into the PRA area, and secondly makes an

assessment of the likely economic impact if that should happen. Each risk factor is assigned a rating: **negligible, low, medium or high** and each rating is given a corresponding numeric score (see Table 3). The rating is assigned based on the replies to a series of questions. In most cases, guidelines or qualifiers are provided following each question to help identify the appropriate risk ratings. It is important to especially identify the high or low risks. The assessor should add, to all replies, any detail which appears relevant indicating the source of information used. From these assessments, the overall level of risk associated with the pest is estimated. This in turn is used in the pest risk management phase while determining whether necessary phytosanitary measures are required to prevent the introduction of the pest, and if the selected mitigation measures are appropriate for that level of risk.

Answer as many of the following questions as possible. If any question does not appear to be relevant for the pest concerned, it should be noted as "irrelevant". If any question appears difficult to answer, no judgement should be given, but the user should note whether this is because of the lack of information or uncertainty. In any case, the assessor should score such questions based on careful judgement which should justify the exclusion of the question or the scoring of this question as high risk due to the level of uncertainty associated with the question.

Table 3. Description of likelihoods and corresponding numeric score (adapted from IPPC 2005; Department of Agriculture and Water Resources, Australia 2016).

Likelihood	Description	Numeric score
High	The event is very likely to occur	6
Medium	The event would occur with even probability	3
Low	The event is unlikely to occur	1
Negligible	The event would almost certainly not occur	0

2.2.2.1 Probability of introduction

Introduction, as defined by the Glossary of Phytosanitary Terms (ISPM No. 5), is the entry of a pest resulting in its establishment.

Probability of entry of a pest

The entry potential depends on the pathways from the exporting country to the destination, and the frequency and quantity of pests associated with them. Documented pathways for the pest to enter new areas should be noted.

Identification of pathways

Assessment has to consider all factors associated with each pathway that a pest may be associated with from its point of origin to its establishment in the PRA area. As such, if a PRA is conducted for commodity pathway, then probability of entry is assessed for the commodity as well as any other pathways such as packing materials. If a PRA is initiated for a specific pest, then all possible pathways e.g., import of commodities (hosts), types of passages such as human-assisted, or types of transport associated with that pest, should be assessed.

Data on detections in imported consignments may indicate the ability of a pest to be associated with a pathway. For a PRA initiated by the identification of a pathway, this is the main pathway to be considered.

Risk assessments initiated for specific pest, with no particular commodity or pathway under consideration, the entry potential of all possible pathways should be considered.

For pathways consisting of **intentionally imported plants (do not consider entry)**, go directly to establishment (**Step 33**). Spread from the intended habitat to the unintended habitat which is an important judgement for intentionally imported plants is covered by **Steps 47-48 (probability of spread)**.

Step 20. Consider all relevant pathways and list them.

Relevant pathways are those with which the pest has a possibility of being associated (in a suitable life stage), on which it has the possibility of survival, and from which it has the possibility of transfer to a suitable host. Make a note of any obvious pathways that are impossible and record the reasons.

Many factors need to be considered to identify pathways for entry. For example:

- a. Life history of the pest
- b. Plant parts affected which may serve as reservoir or carrier of the pest
- c. Production and harvesting practices in the country of origin
- d. Trade patterns and practices
- e. Volume and frequency of consignments

Go to Step 21

Step 21. Estimate the number of relevant pathways, of different commodities, from different origins, to different end uses. (e.g., pest-initiated PRA – how many pathways does the pest have; what is the probability of the pest entering? Pathway PRA – assess how many potential quarantine pests could enter by the pathway and what they are.

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- One pathway

Low:

- Two pathways

Medium:

- Three pathways

High:

- More than three pathways

Go to Step 22

Step 22. Select from the relevant pathways, using expert judgement, those which appear most important. If these pathways involve different origins and end uses, it is sufficient to consider only the realistic worst-case pathways. The following group of questions on pathways is then considered for each relevant pathway in turn, as appropriate, starting with the most important.

Go to Step 23

Probability of the pest being associated with the individual pathway at origin

Step 23. How likely is the pest to be associated with the pathway (usually with a commodity) at origin?

Negligible, Low, Medium, High:

Consider the following for ratings. Assess the conditions to choose the appropriate rating and use scientific evidence and expert judgments as deemed necessary. **For example**, the pest may be of low prevalence but the commodity is the preferred host of the pest. This indicates that the chance of the pest being present on the commodity is 'high' even though its prevalence in the field or at origin is low. However, if effective management is available and practiced or applied as part of the production and post-harvest scheme, then a rating of 'Medium' may be accorded even if the commodity is a preferred host.

Negligible:

- Pests present in limited areas in the place of origin; pest free area well documented

Low:

- Low pest prevalence in the place of origin
- Commodity being imported is not a preferred host of the pest
- Viable life stages are unlikely at the time of harvest and/or on harvested commodity
- Pest is not usually associated with the plant part being imported

Medium:

- Commodity is an occasional host
- Effective management practices applied before harvest
- Effective post-harvest treatment applied before transportation

High:

- The commodity or the plant part being imported is a preferred host and a preferred feeding site of the pest.
- No effective management practices exist or conducted

Goto Step 24

Step 24. How large is the volume of the movement of commodity along the pathway?

Negligible, Low, Medium, High:

Consider the following (consignments that do not fall within the following negligible category must be assessed differently from the factors given below):

Negligible:

- Less than 10 MT in a week

Low:

- Up to 20MT in a week

Medium:

- Up to 30 MT in a week

High:

- >30 MT in a week

Goto Step 25

Step 25. How frequent is the movement of commodity along the pathway?

Negligible, Low, Medium, High:

Negligible:

- Once a year

Low:

- Once a month

Medium:

- Once a week

High:

- More than once a week

Goto Step 26

Probability of survival during transport or storage

Step 26. What is the probability of the pest **surviving** and **multiplying** during transport/storage?

Negligible, Low, Medium, High:

Consider the following (Data on pest interception if available is useful at this stage):

Negligible:

- *Highly likely that the entire pest population will be killed or eradicated prior to storage or transport by effective treatment practices*

Low:

- *Storage and transport conditions significantly reduce pest populations, not conducive for survival or multiplication e.g., refrigerated and/or modified atmosphere*

Medium:

- *Storage and transport conditions are not refrigerated & transport duration is long contributing to pest build up while in transit*

High:

- *Pest has hardy dormancy or survival structures e.g., sclerotia in some fungi*

Goto Step 27

Probability of the pest surviving existing pest management procedures

Step 27. What is probability of the pest surviving or remaining undetected during existing phytosanitary measures?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *Damages, and signs and symptoms are easily visible to the naked eye*
- *Effective measures that can kill or eradicate the pest are available and applied between the point of origin and end use*

Low:

- *Signs and symptoms are visible on the external surface and can be detected using hand lens or microscope*

Medium:

- *Pest can be detected through destructive sampling (cut open)*
- *Control measures are not certain to eliminate the pest*

High:

- *Pest can be detected using only specific diagnostic techniques in the laboratory (e.g., requires to be cultured, or undergo serological and/or molecular tests)*
- *No effective control measures are available*

Goto Step 28

Probability of transfer to a suitable host or habitat

Step 28. In the case of a commodity pathway, how widely is the commodity to be distributed throughout the PRA area?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *Will be distributed to one local area (e.g., village)*

Low:

- *Will be distributed in one gewog*

Medium:

- *Will be distributed in one dzongkhag*

High:

- *Will be distributed in more than two dzongkhags*

Go to Step 29

Step 29.In the case of a commodity pathway, do consignments arrive at a suitable time of year for pest establishment?

Yes – Go to Step 30

No – Go to Step 32

Step 30. How likely is the pest to be able to transfer from the pathway to a suitable host or habitat? (for hosts list, refer Step 14).

Negligible, Low, Medium, High:.....

Consider the following (Note- if no information is available rate it as 'high')

Negligible:

- *Host distribution is limited to one place e.g., one gewog*
- *Pest (or its life stage) is unlikely to disperse on its own*
- *Vector or other agent capable of assisting contact with host is absent in PRA area*

Low:

- *A few suitable hosts within the same genus present*
- *Host(s) distribution is limited to a gewog*
- *Pest dispersal on its own is limited*
- *Vector prevalence is low e.g., limited to a few places*

Medium:

- *Hosts belonging to one family present*
- *Host(s) present in more than one region*
- *Destination close to production areas e.g., farms and orchards*

High:

- *Hosts belonging to more than one family present*
- *Host(s) distributed widely over the PRA areas*
- *Vectors prevalent or pests can easily move around on its own*

Goto Step 31

Step 31.In the case of a commodity pathway, how likely is the intended use of the commodity to aid transfer to a suitable host or habitat?

Negligible, Low, Medium, High:.....

Consider the following:

Negligible:

- *If intended for use in post quarantine facility after which it is destroyed*

Low:

- *If intended for research purpose to be used under controlled environment and quarantine facility in the research centres.*
- *If intended for processing*

Medium:

- *If intended for consumption (consider waste disposal under both household and retail market condition that may result in intentional or accidental propagation)*

High:

- *If the commodity is for planting or propagation*

Goto Step 32

Consideration of further pathways

Step 32.Do other pathways need to be considered?

Yes – Go to back to Step 23

No – Go to conclusion on probability of entry & then Go to Step 33 of Section 2.2.2.2 – Probability of establishment

Conclusion of probability of entry

Describe overall probability of entry and identify the risks presented by different pathways.

2.2.2.2 Probability of establishment

Estimating the establishment potential of a pest requires reliable biological information (i.e., life cycle, host range, epidemiology, survival etc.) and should be obtained from the area where the pest currently occurs. If information is lacking or incomplete then, other resources, e.g., CABI, must be referred to for such information. Conditions in the PRA area are then compared to the area where the pest occurs to assess the probability of establishment.

For plants which are intentionally imported, the assessment of the probability of establishment concerns the unintended habitat.

Availability of suitable hosts or suitable habitats, alternate hosts and vectors in the PRA area

Step 33.Specify the host plant species (for pests directly affecting plants) or suitable habitats present in the PRA area. Prepare a host list (**Refer Step 14**), estimate the number of host plant species or suitable habitats in the PRA area for inclusion in the PRA report.

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- At least one host species present in the PRA area

Low:

- Hosts belonging to more than 1 species but belonging to the same genus present

Medium:

- Hosts belonging to 1 family present
- Hosts present in more than one region

High:

- Hosts belonging to more than one family present
- Host distributed widely over the PRA area (indicating wide habitats)

Go to Step 34

Step 34.How widespread are the host plants or suitable habitats in the PRA area? (specify)

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Hosts limited to one agro-ecological zone

Low:

- Hosts limited to two agro-ecological zone

Medium:

- Hosts limited to three agro-ecological zones

High:

- Hosts limited to more than three agro-ecological zones

Go to Step 35

Step 35. If an alternate host is needed to complete the life cycle, how widespread are alternate host plants in the PRA area? (not relevant for parasitic plants).

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Alternate hosts limited to one agro-ecological zone

Low:

- Alternate hosts present in two agro-ecological zones

Medium:

- Alternate hosts present in three agro-ecological zones

High:

- Alternate hosts present in more than three agro-ecological zones

Go to Step 36

Step 36. If the pest requires another species for critical stages in its life cycle such as transmission, (e.g., vectors), growth (e.g., root symbionts), reproduction (e.g., pollinators) or spread (e.g., seed dispersers), how likely is the pest to become associated with such species?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Vector present but other assisting agents are absent from the PRA area

Low:

- Vector(s) and other agents are prevalent in one agro-ecological zone

Medium:

- Vector(s) and other agents are commonly prevalent (in two agro-ecological zones)

High:

- Vector(s) and other agents are prevalent in more than two agro-ecological zones

Go to Step 37

Suitability of the environment

Step 37. How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution? *Good understanding or knowledge of climatic zones and growth conditions of the pest is required. Climate classification of Koppen Geiger may be useful for understanding the different climatic zones of the world.*

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Evidence from pest biology and studies in other places indicate that the pest cannot survive climatic conditions in the PRA area

Low:

- Suitable climatic conditions occur in the PRA area only occasionally and under extreme conditions (unusual rainfall, cold front etc.)

Medium:

- Some conditions e.g., either temperature or humidity or rainfall, are present but not others

High:

- All conditions suitable for pest establishment are present

Go to Step 38

Step 38. If protected cultivation (e.g., greenhouse) is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere? (If protected cultivation such as greenhouse cultivation is not practiced, this step may be excluded from the assessment and also from scoring estimation).

Negligible, Low, medium, High:

Consider the following:

Negligible:

- Never been recorded in protected cultivation

Low:

- Rarely (once or twice) been recorded in protected cultivation

Moderate:

- Often (almost every season)

High:

- Present all the time

Go to Step 39

Step 39. Probability of establishment of the pest due to the presence/absence of competitive existing species or natural enemies in the PRA area.

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Abundant competitive species or predators known to occur in the PRA area

Low:

- At least two species of competitive or predatory nature present

Medium:

- At least one species of competitive or predatory nature present

High:

- No competitive species or predators known to occur in the PRA

Go to Step 40

Cultural practices and control measures

Step 40. How likely it is that existing control or husbandry measures will fail to prevent establishment of the pest?

Negligible, Low, Medium, High:

Consider the following:

Negligible

- Unlikely to fail due to availability and practice of effective measures

Low

- Slightly likely to fail due to non-practice of available effective measures

Medium

- Existing measures are moderately effective

High

- Existing measures are either ineffective or effective but expensive

Go to Step 41

Step 41.What is the probability that the pest could survive eradication programmes in the PRA area? (*This requires to consider whether Bhutan can implement eradication programmes effectively or not*).

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Affordable and effective eradication programme in practice

Low:

- Eradication programme available and applicable making the pest unlikely to survive

Medium

- Eradication programme present but expensive and not adopted

High

- No eradication programme

Go to Step 42

Other characteristics of the pest affecting the probability of establishment

Step 42.How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment? (consider long term dormancy life cycle such as sclerotia, thick-walled resting spores, etc.,).

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Easily desiccates; low reproduction; single generation etc.

Low:

- Can remain dormant; uni-voltine; monocyclic

Medium:

- Polycyclic; bi-voltine

High:

- Long term dormancy and other survival mechanisms; r-strategist (high reproduction rate & high generation number; polycyclic; multi-voltine)

Go to Step 43

Step 43.How likely are relatively small populations or populations of low genetic diversity to become established?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Need a large number to establish

Low:

- Require some numbers or small quantities to establish

Medium:

- Requires a small batch to establish

High:

- A few individuals can establish colony that can perpetuate; OR no information or uncertain

Got to Step 44

Step 44.How adaptable is the pest?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- Evidence of low e.g., geographical range and host range
- Low** (If any one of the following applies):
- Evidence of limited geographic range
 - Evidence of limited host range e.g., one species
- Medium:**
- Evidence of related species known to be adaptable pests
- High** (If any one of the following applies):
- No information available
 - Evidence of changes in pest behaviour and its adaption to different geographical ranges
 - Evidence of changes in pest behaviour and its adaption to different host ranges
 - Records of different strains or forms of the pest with different damage potential or adaptations to different hosts

Go to Step 45

Step 45.How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances, if possible).

Negligible, Low, Medium, High:

Consider the following:

- Negligible:**
- Never
- Low:**
- Very rarely (e.g., one time)
- Medium:**
- Often (e.g., two-three times)
- High:**
- Very often (more than three times)

Go to Step 46

Step 46.Even if permanent establishment of the pest is unlikely, how likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment)?*If information is lacking, rate it high.*

Negligible, Low, Medium, High:

Consider the following:

- Negligible:**
- Evidence of no transient nature
- Low:**
- One record
- Medium:**
- Few records
- High**
- Well documented evidence of transient nature or no information or uncertain

Go to Step 47 of probability of spread

2.2.2.3 Probability of spread

Step 47.How likely is the pest to spread rapidly in the PRA area by natural means or human assistance?

Negligible, Low, Medium, High:.....

Consider the following:

- Negligible**(if any of these applies):
- No evidence that the pest is spreading or has spread in other parts of the world
 - The pest requires specific vectors for dispersal that are not present in the PRA area

- *The dispersal stage of the pest requires special conditions that do not occur in the PRA area*
- Low**(if any of these applies):
- *The pest has low reproductive potential and/or limited natural dispersal capacity*
 - *Vectors and other dispersal agents are present but prevalence is low*
 - *Spread of the pest in other parts of the world has been slow and limited*
- Medium**(if any of these applies):
- *Pest has either high reproductive potential or is capable of rapid dispersal*
 - *The pest is capable of dispersal through widely prevalent vectors*
- High**(if any of these is evident):
- *Evidence exists that the pest is capable of rapid dispersal on its own, via natural forces (e.g., wind, water), by vectors & human assistance*
 - *Evidence exists that the pest is spreading or has spread in other parts of the world*

Go to Step 48

Step 48.How likely is it that the spread of the pest will not be contained within the PRA area?

Negligible, Low, Medium, High:

Consider the following:

- Negligible:**
- *Complete containment; effective measures in place*
- Low:**
- *Effective measures available making containment feasible*
- Medium:**
- *Effective measures available but expensive and not adopted*
- High**
- *Cannot be contained; no effective measures available*

Go to conclusion on introduction and spread

Conclusion of introduction and spread

1. Use Tables 4 and 5 to estimate the likelihood of entry, establishment and spread.
2. Using Table 4:
 - a. Count the number of responses in the **Steps**receiving ratings of **negligible**for **probability of entry** and record in the column designated as ‘**number of responses**’ in Table 4. Repeat for low, medium and high ratings.
 - b. Multiply the number of responses by its corresponding ‘**numeric score**’ for each rating. Record the product in the ‘**score**’ column. Add the scores of all the ratingto obtain the ‘**combined score**’ for probability of entry.
 - c. Repeat Steps **a**and **b** for **probability of establishment, probability of spread** and **economic consequences**.
3. Using Table 5:
 - Compare the ‘**combined score**’, obtained in No. 2, with the ‘**scoring range**’ in Table 5 to obtain the estimated ‘**risk**’ for each category and indicate the risk level in the bottom row of each category. E.g., if a combined score of 11 is obtained for probability of entry in Table 4, then the **risk** is **medium** for that category as 11 falls in the range of 10 -27 which is **medium**.

Go to conclusion on endangered areas

Conclusion regarding endangered areas

- a. Based on the answers in **Steps 33 to 48**, identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area
- b. Go to Assessment of potential consequences

Table 4. Estimation of risk scores for entry, establishment, spread and economic consequences

Scoring		Category							
		Probability of entry		Probability of establishment		Probability of spread		Economic consequence	
Rating	Numeric score	Number of responses	Score (Numeric score x No. of responses)	Number of responses	Score (Numeric score x No. of responses)	Number of responses	Score (Numeric score x No. of responses)	Number of responses	Score (Numeric score x No. of responses)
Negligible	0								
Low	1								
Medium	3								
High	6								
Combined score									

Example: Probability of entry has a total of 9Steps/questions. Three are rated negligible, then the score would be $0 \times 3 = 0$; zero received medium = $3 \times 0 = 0$; 3 questions rated 'High', then the score would be $6 \times 3 = 18$; combined score = $0 + 0 + 18 = 18$

Table 5. Risk estimation (number of Steps/questions requiring rating is given in parenthesis)

Rating	Numeric score	Risk for each category			
		Probability of entry (9 steps)	Probability of establishment (14 steps)	Probability of spread (2 steps)	Consequence (9 steps)
Negligible	0	0	0	0	0
Low	1	1 – 9	1 – 14	1 – 2	1 – 9
Medium	3	10 – 27	15 – 42	3 – 6	10 – 27
High	6	28 – 162	43 – 252	7 – 36	28 – 162
Risk score (High, Medium, Low, or Negligible)					

2.2.2.4 Assessment of potential consequences

The main purpose of this section is to determine whether the introduction of the pest will have unacceptable consequences (economic, environmental and social). In cases where the organism has already entered and is established in part of the PRA area, responses to questions (i.e., **Steps 51, 55 and 57**), which refer to impacts in its area of current distribution, should be based on an assessment of current impacts in the PRA area in addition to impacts elsewhere.

Expert judgement is used to provide an evaluation of the likely scale of impact. If precise economic evaluations are available for certain pest/crop combinations, it will be useful to provide details.

The responses/replies should take account of both short-term and long-term effects of all aspects of agricultural, environmental and social impact.

Consider potential hosts/habitats identified in **Step 33** when answering the following questions:

Pest effects

For Steps 49-50, consider the following **pest effects**:

- Reduction in yield of host crop due to production losses or loss of marketable commodity
- Reduction in value of host due to quality loss or diverted market
- Loss of domestic or export market
- Increased production cost
- Introduced regulatory cost (e.g., phytosanitary measures)

Step 49. How great a negative effect does the pest have economically in its **current area of distribution**?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *The pest has none of the above pest effects*

Low:

- *The pest is likely to cause one of the above pest effects*

Medium:

- *The pest is likely to cause two of the above pest effects*

High:

- *The pest is likely to cause three or more of the above pest effects*

Step 50. How great a negative effect is the pest likely to have economically in **the PRA area**?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *The pest has none of the above pest effects*

Low:

- *The pest is likely to cause one of the above pest effects*

Medium:

- *The pest is likely to cause two of the above pest effects*

High:

- *The pest is likely to cause three or more of the above pest effects*

Go to Step 51

Environmental effects

For Steps 51 and 52, consider the following environmental impacts:

- Reduction of ecologically significant species by direct infestation
- Destruction of habitat thereby threatening or endangering other species
- Stimulate the use of biological or chemical control programmes
- Reduction in biodiversity

Step 51.How important is environmental damage caused by the pest **within its current area of distribution?**

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *The pest has none of the above environment effects*

Low:

- *The pest is likely to cause one of the above environmental effects*

Medium:

- *The pest is likely to cause two of the above environmental effects*

High:

- *The pest is likely to cause three or more of the above environmental effects*

Go to Step 52

Step 52.How important is the environmental damage likely to be in the **PRA area?**

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *The pest has none of the above environment effects*

Low:

- *The pest is likely to cause one of the above environmental effects*

Medium:

- *The pest is likely to cause two of the above environmental effects*

High:

- *The pest is likely to cause three or more of the above environmental effects*

Go to Step 53

Social impacts

For Steps 53 and 54, use the following social impacts:

- Loss of employment
- Loss of land use function (agriculture and living area)
- Contribution to aesthetic value, historical value
- Impact on water quality, animal grazing and fishing or aquatic lives
- Impacts on other industries e.g., tourism, energy etc.

Step 53.How important is the social damage caused by the pest within its **current area of distribution?**

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *The pest has none of the above social impacts*

Low:

- *The pest is likely to cause one of the above social impacts*

Medium:

- *The pest is likely to cause two of the above social impacts*

High:

- *The pest is likely to cause three or more of the above social impacts*

Go to Step 54

Step 54.How important is the social damage likely to be in the **PRA area**?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *The pest has none of the above social impacts*

Low:

- *The pest is likely to cause one of the above social impacts*

Medium:

- *The pest is likely to cause two of the above social impacts*

High:

- *The pest is likely to cause three or more of the above social impacts*

Go to Step 55

Step 55.How easily can the pest be controlled in the PRA area?

Negligible, Low, Medium, High:

Consider the following:

Negligible:

- *Can be controlled easily; effective measures are not expensive*

Low:

- *Adequate information on pest management available making control feasible*

Medium:

- *Only a few possible and expensive control measures are known*

High:

- *No effective measures are known; very expensive*

Go to conclusion of the assessment of consequence

Conclusion of the assessment of consequences

- a. Transfer ratings of consequences to Tables 4 and 5
- b. Transfer results to PRA report
- e. Continue with the following sections

2.2.3 Degree of uncertainty

Estimation of the probability of introduction of a pest and of its economic consequences involves many uncertainties. In particular, this estimation is an extrapolation from the situation where the pest occurs to the hypothetical situation in the PRA area. It is important to document the areas of uncertainty and the degree of uncertainty in the assessment, and to indicate where expert judgement has been used.

This is necessary for transparency and may also be useful for identifying and prioritizing research needs.

It should be noted that the assessment of the probability and consequences of environmental hazards of pests of uncultivated plants often involves greater uncertainty than for pests of cultivated plants. This is due to the lack of information, additional complexity associated with ecosystems, and variability associated with pests, hosts or habitats.

Uncertainty may be due to the following factors among others:

Flaws in methodology;

Imprecision in data;

Statistical variations;

Barriers to obtaining information;

Lack of expertise;

Natural variability in data;

Diseases of uncertain aetiology;

Biological unknowns of the pest or pathways;

Incomplete or inconsistent or conflicting data;

Subjective judgement

Seek experts' opinions and judgement wherever possible. In any case, it is important to document the areas of uncertainty and degree of uncertainty in pest assessment and indicate where expert judgement and assumptions have been used.

Step 56. *For pest-initiated risk assessments – Goto conclusion of the risk assessments*

Step 57. *For pathway-initiated risk assessments - Go back to Step 23 to evaluate the next pest. If all pests have been evaluated, go to conclusion of the risk assessment.*

2.2.4 Conclusion of the pest risk assessment

Assigning the likelihood of entry, establishment and spread

The risk assessor should give an overall conclusion on the pest risk assessment and an opinion as to whether the pest or pathway assessed is an appropriate candidate for **Stage 3** of the PRA: the selection of risk management options, and an estimation of the pest risk associated.

1. For the purpose of this standard, use the matrix in Table 6 to estimate the likelihood of entry (E) and establishment (E), and the combined likelihood of entry and establishment (EE) with the likelihood of spread (S).

e.g., Likelihood 1 x Likelihood 2, which would be:

(1) Likelihood of entry (E) x Likelihood of establishment (E) = EE

(2) Likelihood of EE x Likelihood of spread (S) = EES

EXAMPLE: From Table 5, if the rating for entry is 'High' and establishment is 'Medium', and spread is 'Low' then using the matrix in Table 6:

(1) Likelihood of entry (E) x Likelihood of establishment (E)

EE = High x Medium

EE = Medium

(2) Likelihood of EE x Likelihood of spread (S)

EES = Medium e x Low

EES = Low

2. Use the matrix in Table 7 to estimate the overall risk by combining the likelihood of entry, establishment and spread with the likelihood of consequences.

EXAMPLE: Likelihood of entry, establishment and spread (EES) is LOW and consequence rating is MEDIUM

Overall risk = EES x Likelihood of consequence = LOW x MEDIUM

From Table 7:

LOW x MEDIUM is LOW

Therefore, the overall risk is LOW

Table 6. Matrix for combining likelihood (adapted from the Department of Agriculture and Water Resources, Australia 2016).

		Likelihood 2			
		High	Medium	Low	Negligible
Likelihood 1	High	High	Medium	Low	Negligible
	Medium		Low	Low	Negligible
	Low			Negligible	Negligible
	Negligible				Negligible

Table 7. Overall risk matrix (adapted from the Department of Agriculture and Water Resources, Australia 2016).

		Consequences			
		Negligible	Low	Medium	High
Likelihood of entry, establishment and spread (EES)	High	Negligible	Low	Medium	High
	Medium	Negligible	Low	Medium	High
	Low	Negligible	Negligible	Low	Medium
	Negligible	Negligible	Negligible	Negligible	Low

Acceptability of risk: Appropriate level of sanitary or phytosanitary protection (also referred to as acceptable level of risk)

Appropriate level of sanitary or phytosanitary protection (also referred to as acceptable level of risk) is defined as ‘the level of protection deemed appropriate by the WTO Member States establishing the sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. The acceptable level of risk for this standard used in Bhutan is ‘**LOW**’. Assessment rating above this level will require phytosanitary measures to reduce to pest risk level.

Step 58. Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?

Yes – STOP PRA here, transfer the results of the risk assessment to the PRA report using the format in Table 8 and furnish the PRA report.

No – Transfer the results of the risk assessment to the PRA report using the format in Table 8 and Go to 2.3 Stage 3 – Risk management

2.3 Stage 3: Pest risk management

The pest risk management stage uses the conclusion from the previous stage of pest risk assessment. If the pest risk is found to be of unacceptable level after risk assessment, then pest management measures are identified in this stage to reduce the pest risk to an acceptable level. Risk management should be applied to all pests or pathways being considered in the PRA as pest may enter via many pathways and a pathway may introduce many pests. Pest management measures include measures to prevent entry, establishment or spread of a pest which can be implemented at the (i) exporting country; (ii) the point of entry; and (iii) in the importing country.

The process in this stage is followed as:

- Identification of appropriate phytosanitary measures – risk management options are considered according to whether the introduction is intentional or unintentional;
- Assessment of the identified measures for cost-effectiveness and efficacy;
- Selection of appropriate phytosanitary measures - the least stringent options must be considered over the expensive and disruptive ones.

2.3.1 Identification of appropriate risk management options

This section examines the characteristics of the pest to determine if the pest can be reliably detected in consignments by inspection or testing, if it can be removed from consignments by treatment or other methods, if limitation of use of the commodity would prevent introduction, or if the pest can be prevented from infecting/infesting consignments by treatment, production methods, inspection or isolation. "Reliably" should be understood to mean that a measure is efficient, feasible and reproducible. Measures can be reliable without being sufficient to reduce the risk to an acceptable level. In such cases their combination with other measures to reach the desired level of protection against the pest should be envisaged (see **Step 84**). When a measure is considered reliable but not sufficient, the assessor should indicate this. The efficiency,

feasibility and reproducibility of the measures should be evaluated by the assessor for each potential management option identified. Limitations of application of measures in practice should be noted. Cost effectiveness and impact on trade are considered in the section “evaluation of risk management options” (**Steps 86 to 88**).

Phytosanitary measures common to traded commodities which are applied to pathways e.g., consignments of a host, from a specific origin include measures:

- applied to prevent or reduce original infestation in the country of origin
- applied to the consignment and commodities
- to ensure the area of production is free from pest
- concerning the restriction or prohibition of commodities
- applied during pre- and post- harvest handlings
- applied within the importing country

Table 8. Risk level and risk management measures for quarantine pests associated with import of (commodity name(s)).....from(exporting country)..... to Bhutan.

Host & pest scientific name	Pest risk	Risk management measures	
		Exporting country (.....)	Importing country (Bhutan)
<i>Host A</i> <i>Pest A</i>	Medium	hot water treatment; PSC; etc.	Inspections at entry and remedial actions etc.

Examples of potential phytosanitary measures to manage pest risk:

Pathway points	Mitigation measures
Pre-harvest (exporting country)	Pest-free areas or areas of low pest prevalence Resistant cultivars Healthy planting material Sanitation and cultural controls Certification schemes Testing Protected conditions
Harvest (exporting country)	Harvesting at specific times or at specific stages of ripeness/maturity Culling infested products Field sanitation Harvest techniques In-field chemical treatments Field surveillance
Post-harvest handling (exporting country)	Post-harvest treatments e.g., heat, chemical, waxing, washing Testing Culling Packhouse inspection Processing
Shipping (exporting country)	Treatment in transit (e.g., cold treatment) Speed and type of transport Pre-shipment inspection Testing
Entry (importing country)	Restriction on ports of entry Post-entry quarantine Post-entry inspection Post-entry treatment
End use (importing country)	Restriction on end use Post-entry processing
Other compliance measures	Phytosanitary certificates

Risk associated with pathways

Pest-initiated analysis

In case of analysis for unintentional introduction of a pest go to **Steps 59 to 66** which relate to different pathways on which the pest may be carried.

For intentional import of plants (ornamental plants, plants intended for planting), phytosanitary measures should be focused on preventing the introduction, establishment and spread of organism in unintended habitats in the PRA area. For such cases, proceed from **Step 81 onwards**. However, if the organism is also entering the area unintentionally then measures must be required to prevent introduction through unintentional pathways therefore, **Steps 59- 80** should also be followed.

Pathway-initiated analysis for plants and plant products

In case of a pathway-initiated analysis for a commodity of plants and plant products, start with **Step 67** since the precise pathway is known. Repeat the process as far as **Step 93** for each pest identified as requiring pest management in the pest risk assessment. When all pests have been considered, go to **Step 94** to integrate the measures for the commodity.

Step 59. Is the pathway that is being considered a commodity of plants and plant products?

If yes – Go to Step 67

If no – Go to Step 60

Step 60. Is the pathway that is being considered the natural spread of the pest (see answer to **Step 47**)?

If yes – Go to Step 61

If no – Go to Step 65

Step 61. Is the pest already entering the PRA area by natural spread or likely to enter in the immediate future? (see answer to **Step 47**)

If yes – Go to Step 62

If no – Go to Step 64

Step 62. Could entry by natural spread be reduced or eliminated by control measures applied in the area of origin?

If yes – List the control measures that will be applied in the area of origin as possible measures – Goto Step 63

Step 63. Could the pest be effectively contained or eradicated after entry? (see response in **Steps 41, 48**)?

If yes – List internal containment and/or eradication action as possible measures – Go to Step 64

Step 64. Was the answer "yes" to either **Step 62** or **Step 63**?

If yes – Go to Step 90

If no – Go to Step 96

Step 65. Is the pathway that is being considered the entry of pest associated with human travellers?

If yes – List inspection of human travellers, their luggage, publicity to enhance public awareness on pest risks, fines or incentives, treatments as possible measures – Go to Step 82 (if measures have been identified)

If no – Go to Step 66

Step 66. Is the pathway being considered contaminated machinery or means of transport?

*If yes – List cleaning or disinfection of machinery/vehicles as possible measures
Go to Step 82*

For other types of pathways (e.g., commodities other than plants or plant products, exchange of scientific material, packing material, grain, wool, hides, sand, gravel), not all of the following questions may be relevant;

Go to Step 90

Existing phytosanitary measures

Step 67. Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest?

If yes – List the measures and identify their efficacy against the pest

Options for consignments

Detection of the pest in consignments by inspection or testing

Step 68. Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?

If yes – Adopt visual inspection as a possible measure – Goto 69

Step 69. Can the pest be reliably detected by testing (e.g., for pest plant seeds/weed seeds in a consignment)?

If yes – List the 'specified test' as a possible measure – Goto 70

Step 70. Can the pest be reliably detected during post-entry quarantine?

If yes – List the post-entry quarantine requirement in the permit as a possible measure – Goto 71

Removal of the pest from the consignment by treatment or other phytosanitary procedures

Step 71. Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?

If yes – List the specified treatment (e.g., chemical, thermal) as possible measure(s) – Goto 72

Step 72. Does the pest occur only on certain parts of the plant or plant products (e.g., bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for weeds)

*If yes – List removal of parts of plants as possible measure e.g., if the pest affects calyx then ‘calyx free’ or ‘remove calyx’ would be a possible measure
—Go to 73*

Step 73. Can infestation of the consignment be reliably prevented by handling and packing methods?

*If yes – List the specified handling/packing methods as possible measures –
Goto 74*

Prevention of establishment by limiting the use of the consignment

Step 74. Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?

If yes – List ‘importing under special licence/permit and specified restrictions as possible measure’ – Goto 75

Options for the prevention or reduction of infestation in the crop

Prevention of infestation of the commodity

Step 75. Can infestation of the commodity be reliably prevented by treatment of the crop?

If yes – List the specified treatment and/or period of treatment as possible measures –Go to 76

Step 76. Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for weeds).

If yes – List that consignment should be composed of specified cultivars as possible measures – Goto 77

Step 77. Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g., protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water)?

If yes – List the specified growing conditions as possible measures – Goto 78

Step 78. Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?

If yes – List the specified date of plant, growth stage or time of year of harvest as possible measures – Goto 79

Step 79. Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e., official scheme for the production of healthy plants for planting)?

If yes – List certification scheme as possible measures – Goto 80

Establishment and maintenance of pest freedom of a crop, place of production or area

Note that in this set of questions, pest spread capacity is considered without prejudice to any other measure that can be recommended. For some pests, growing the plant in specific conditions can prevent natural spread (e.g., production in a glasshouse may

provide protection against pest with high capacity for natural spread). These measures should be identified in **Step 79**.

Step 80. Can pest free crop, pest free place of production or an area be reliably guaranteed?

If Yes – List pest free of the crop, place of production or an area as possible measures – Goto 85 (e.g., if a pest has low capacity to spread then pest free crop may be a possible measure OR if a pest occurs only in a specific area then possible measure would be to exclude import from that particular place)

Consideration of other possible measures

Step 81. Are there effective measures that could be taken in the importing country to prevent establishment and/or economic or other impacts?

If no – possible measures include internal surveillance and/or eradication campaign -Goto 82

2.3.2 Evaluation of risk management options

This section evaluates the risk management options and considers in particular their cost effectiveness and potential impact on international trade. One or more pest risk management options may then be selected based on their costs and overall benefits. Pest management options that prevent risks are preferable than those that control them. The following factors are useful and applied in the following steps of assessment of management options:

- Effectiveness in achieving the expected outcome—does the measure have the effect that is desired, for example, does it kill all the insects in the consignment?
- Efficiency in achieving the expected results—is the measure appropriate for what is required to have the desired result?
- Reproducibility—will the treatment have the same results each time it is applied in the same manner to the same product?
- Cost-effectiveness—does it cost less to apply the pest risk management option than to not apply it and experience the effects of the pest? Is there a less costly option available that would have the same results?
- Potential adverse consequences to human health, economic values, plant and/or animal health, environmental values etc. associated with each option—does the option increase certain risks while reducing others? Are there possible negative impacts of the measure? How could the risks be reduced or eliminated?
- Expected costs associated with each option including resource and time requirements as well as monetary costs—what are the treatment costs, both to the importer and to the NPPO administering it?
- Impacts the resource requirements have on other programs—will expending resources on this activity result in an inability to deliver other programs and will there be negative consequences?

Step 82. Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest?

If yes – List the possible measures (obtained in the previous steps) and Goto 83

If no – Goto 84

Step 83. Taking each of the measures identified individually, does any measure on its own reduce the risk to an acceptable level?

If yes – List and Goto 86

If no – Goto 84

Step 84. For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?

If yes – List the combination of measures and Goto 86

If no – Goto 85

Step 85. If the only measures available reduce the risk but not down to an acceptable level, such measures may still be applied, as they may at least delay the introduction or spread of the pest. In this case, a combination of phytosanitary measures at or before export and internal measures should be considered.

Go to 86

Step 86. Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.

State interference with international trade if any, and Go to 87

Step 87. Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.

Record all - Go to 88

Step 88. Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?

If yes for pathway-initiated analysis – Goto 91

If yes for pest-initiated analysis – Goto 90

If no – Goto 89

Step 89. Envisage prohibiting the pathway.

For pathway-initiated analysis – Go to Step 91

For pest-initiated analysis – Go to Step 90

Step 90. Have all major pathways been analysed for a pest-initiated analysis?

If yes – Goto 93

If no – Goto Step 67 to analyse the next major pathway

Step 91. Have all the pests been analysed for a pathway-initiated analysis?

If yes – Goto Step 92

If no - Go to Step 67 to analyse the next pest

Step 92. For a pathway-initiated analysis, compare the measures appropriate for all the pests identified for the pathway that would qualify as quarantine pests, and select only those that provide phytosanitary security against all the pests.

Go to Step 9

Step 93. Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment (i.e., pathways of high risk).

Go to Step 94

Step 94. All the measures or combination of measures identified as being appropriate for each pathway or for the commodity can be considered for inclusion in phytosanitary regulations in order to offer a choice of different measures to trading partners.

Go to Step 95

Step 95. In addition to the measure(s) selected to be applied by the exporting country, a phytosanitary certificate (PSC) may be required for certain commodities. The PSC is an attestation by the exporting country that the requirements of the importing country have been fulfilled. In certain circumstances, an additional declaration on the PSC may be needed (see ISPM 12 – Phytosanitary certificates 2017).

Go to –Step 96

Step 96. If there are no measures that reduce the risk for a pathway, or if the only effective measures are not cost-effective or have undesirable social or environmental consequences, the conclusion of the pest risk management stage may be to prohibit importation.

Go to Conclusion of pest risk management

2.3.3 Conclusion of pest risk management- selection of appropriate phytosanitary measures

Summarize the conclusions of the pest risk management stage. The pest risk management may result in either selecting one or more phytosanitary measures to reduce the pest risk or no appropriate phytosanitary measure identified. List all potential management options and indicate their effectiveness as identified in the above steps. Then, select the most appropriate phytosanitary measures against each pest following the format in Table 8. Document the reasons for selecting the preferred options and identify any uncertainties. The following considerations which include some of the phytosanitary principles outlined in ISPM 1 is useful in selecting the phytosanitary measures:

- Phytosanitary measures should be cost-effective and feasible, cost-benefit analysis for each of the minimum measures may be estimated.
- Phytosanitary measures should have minimal trade impact.
- No additional measure should be imposed if effective measures exist.
- Measures with same effect must be accepted as alternatives.
- Phytosanitary measures should not discriminate measures being employed in the exporting countries.

2.4 Monitoring and review of phytosanitary measures

Performance of measure(s) should be monitored to ensure that the aim is being achieved. This is often carried out by inspection of the commodity on arrival, noting any detection in consignments or any entries of the pest to the PRA area.

Information supporting the pest risk analyses should be reviewed periodically to ensure that any new information that becomes available does not invalidate the decision taken.

Step 97. Prepare draft PRA report.

Step 98. Circulate for comments and review (relevant stakeholders).

Step 99. Present the draft PRA report to RNR GHNC for onward submission to exporting country.

Step 100. Finalise PRA report after exporting country has responded to the draft report and present the final PRA report to RNR GHNC for endorsement.

- Ensure both electronic and hardcopies are maintained and are readily available for retrieval by an interested person or agencies within Bhutan or overseas on request. PRA documentation includes:
 - ✓ Purpose of PRA
 - ✓ Pest, pest list, pathways, PRA area and endangered area
 - ✓ Sources of information
 - ✓ Categorised pest list
 - ✓ Conclusion of risk assessment: probability; consequences
 - ✓ Risk management: options identified and options selected

PRA process now completed.

Appendix 1. PRA request form

(Note: This form is to be filled by the PRA review officer (BAFRA))

PRA REQUEST FORM

Client details

Name or Organisation:.....

Address:

Phone:; Email:

PRA general information

Activity (circle one): Import Export

State the reason for PRA:

.....

Product name (common name):

Botanical/Scientific name (genus & species):

Botanical/Scientific name (strain/variety/cultivar):.....

Country of origin:

Quantity/Volume:

Frequency:

Product type (circle one or more)

Processed/Non-processed; Living/Non-living;

Plant/Animal; Genetically modified/non-genetically modified

Seed/Plant/Soil; Culture/non-culture;

Other (specify):

Processing details if applicable

If seed: ground/kibbled/ whole/preserved;

If plant: fresh/dried/ freeze dried/preserved;

Processing refinements: cooked/ frozen/ pulped/ steamed;

Details of treatments:

.....

.....

Product origins (if not relevant, please indicate)

Country:

State/District.....

Locality:

.....

Production method, certification scheme &/or accreditation type:

.....

.....

.....

End use (circle one or more)

Human consumption/ Processing/Stock feed/Pet food/ Fish food/ Seeds for sowing/

Nursery stock/ Multiplication/ Post-entry quarantine/ fertilizers/ Research (*in-vitro/in-vivo*)

Others:

Appendix 2. Information required from the exporting country for conducting PRA in the importing country

This template is for gathering information on each pest or for any commodity that a pest may be associated in the exporting country. References where information is obtained from is useful.

1. Commodity details:
 - a. Current & other scientific names
 - b. Common names (including synonyms)
 - c. Production area and practices (including harvest, pre-harvest and handling procedures, post-harvest, production volume)
 - d. Climatic conditions in the production area
2. Pest(s) details:
 - a. Current scientific name
 - b. Other Scientific Names (synonyms)
 - c. Common Names (and synonyms)
 - d. Notes on Taxonomy and Nomenclature
 - e. Symptoms
 - f. Host Range (list the common names & scientific names for species)
 - g. Ecology and geographical distribution of the pest
 - h. Biology of the pest (life cycle & morphology; survival; adaptability)
 - i. Climatic conditions (e.g., temperature, rainfall, relative humidity, day length) which have been shown to be conducive or suppressive to survival, development, reproduction and dispersal of the pest
 - j. Dissemination and dispersal e.g., by flight; by wind; vector
 - k. Movement in trade and transport e.g., in buds or under barks; records of interception in international trade; contaminants
 - l. Economic impact e.g., direct /indirect damage; crop loss; management cost etc.
 - m. Detection and inspection methods (what to look for: egg masses; mycelia etc.)
 - n. Pest management (integrated, chemical and biological control; records of eradication, certification schemes)
 - o. Natural enemy list (pathogens; parasitoids, predators; parasites)

Appendix 3.Resources&Search Tools (as provided in the EPPO guidelines)

General Search Engines:

- Google (<http://www.google.com/>)
- AllSearchEngines (<http://www.allsearchengines.com/>): A useful collection of search engine websites

Literature Searches:

- Agricola (<http://agricola.nal.usda.gov/>): AGRICOLA (AGRICultural OnLine Access) is a bibliographic database of citations to the agricultural literature created by the U.S. National Agricultural Library.
- Caribbean Journal of Science (<http://caribjsci.org/>): The CJS publishes articles, research notes, and book reviews pertinent to the Caribbean region. Traditional emphasis is on botany, zoology, ecology, archaeology, geology, and paleontology. E-downloads from the last 5 years free, now 3 issues per year.
- E-Journals.org (<http://www.e-journals.org/>): World-wide web virtual library website providing links to numerous scientific (and other) journals. Also provides lists of journals with free internet access.
- Pubmed (<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi>): A service of the U.S. National Library of Medicine, provides access to over 11 million MEDLINE citations back to the mid-1960's and additional life science journals. PubMed includes links to many sites providing full text articles and other related resources.
- Science Direct (<http://www.sciencedirect.com/>): A service which provides almost 2.5 million journal articles online, FOR A FEE.
- Scirus (<http://www.scirus.com/>): Scirus, launched by Elsevier Science, is a comprehensive science-specific search engine designed to chart and pinpoint data, locate university sites and find reports and articles.
- Entomological journals on the web(<http://www.medbioworld.com/bio/journals/insect.html>): E-journals covering entomological topics also has journal lists for arachnology, acarology, and nematology. Includes many free journals.

Early Warning, Pest Alerts and Archives:

- Agriculture Network Information Center (AGNIC), Plant Diseases Announcements (<http://www.agnic.org/pmp/>)
- Center for Invasive Plant Management (<http://www.weedcenter.org/>)
- Cooperative Agriculture Pest Survey program (CAPS) Pest Alerts, Authorization Required (<http://ceris.purdue.edu/caps/pests/pest-alerts/index.html>)
- EPPO Pest Alerts (http://www.eppo.org/QUARANTINE/Alert_List/alert_list.htm): The pests on the Alert List are selected by the European Plant Protection Organization Secretariat,

mainly from the literature but also from suggestions of NPPOs of member countries.

- Invasive Species Emerging Issues (<http://www.invasivespecies.gov/new/emerge.shtml>)
- NAPPO Phytosanitary Alert System (<http://www.pestalert.org/>): North American Plant Protection Organization archived pest alerts, news stories and official reports of emerging pest situations threatening North America.
- National Agricultural Pest Information System (NAPIS) (<http://ceris.purdue.edu/napis/>)
- National Plant Board (NPB) Plant Pest Issues (<http://nationalplantboard.org/issues.html>)
- New Disease Reports (<http://www.bspp.org.uk/ndr/>): From the British Society of Plant Pathology, a rapid e-publication format for new reports encompassing fungi, bacteria, phytoplasmas, viruses and viroids.
- Pestnet (<http://www.pestnet.org/>)
- ProMed (<http://www.fas.org/promed/>): ProMed is the Federation of American Scientists (FAS) policy initiative calling for global monitoring of emerging diseases. ProMed mail is available online and by subscription, and the mail archives provide useful historical pathogen emergence data.
- The Nature Conservancy (TNC) Invasives on the Web (<http://tncweeds.ucdavis.edu/index.html>)
- University of Florida Pest Alert (<http://pestalert.ifas.ufl.edu/>)

General Resources:

General Resources - Online:

- APHIS Raleigh Plant Protection Center: (<http://www.invasivespecies.org/>)
- APHIS Regulated Pest List (PPQ website) (<http://www.aphis.usda.gov/ppq/regpestlist/>)
- Australian Quarantine and Inspection Service (<http://www.daff.gov.au/aqis>)
- Biosecurity New Zealand Risk Analysis Procedures Version 1, Biosecurity New Zealand, 2006. 103 pp (<http://www.biosecurity.govt.nz/files/pests-diseases/surveillance-review/risk-analysis-procedures.pdf>)
- Bureau of Land Management Weeds Website: (<http://www.blm.gov/weeds/>)(search by state)
- CAB International (CABI) Bioscience (<http://www.cabi.org/>)
- CABI Crop Protection Compendium (<http://www.cabi.org/compendia/cpc/index.htm>)
- California Agriculture Magazine (<http://calag.ucop.edu/>)
- California Department of Food and Agriculture(CDFA) (<http://www.cdfa.ca.gov/phpps/pdep/>)
- California Exotic Pest Plant Council (<http://www.caleppc.org/>)
- Canadian Forest Service (http://www.nrcan-rncan.gc.ca/cfs-scf/index_e.html)

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- CFIA Plant Pest Information (<http://www.inspection.gc.ca/english/sci/surv/pesrave.shtml>): The Canadian Food Inspection Agency's plant pest fact sheets.
 - COSAVE (<http://www.cosave.org>): The South Cone Plant Protection Committee (IPPC Regional Plant Protection Organization; Argentina, Brazil, Chile, Paraguay, Uruguay) includes frames for quarantine pests and data sheets.
 - Crop Knowledge Master (<http://www.extento.hawaii.edu/kbase/crop/crop.htm>): University of Hawaii Integrated Pest Management website
 - Department of Agriculture- Western Australia (<http://www.agric.wa.gov.au/>)
 - Ecoport (<http://www.ecoport.org/ep>): A public service partnership between UFL, FAO, and the Smithsonian Institution. A useful biodiversity index that is gathering content.
 - Featured Creatures (<http://creatures.ifas.ufl.edu/>): This site provides in-depth profiles of insects, mites, nematodes, and other organisms that are of interest to Florida's residents. Jointly sponsored by UFL and FL DOACS.
 - FL DOACS (<http://www.doacs.state.fl.us/pi/enpp/triology.html>): The Florida Dept of Agriculture and Consumer Services has indexed circulars (data sheets) compiled since the 1960's. Scope includes botany, nematology, entomology, and plant pathology. They are in the process of scanning the archives, and many are available as pdf files. Files not available electronically can be requested online.
 - Florida Exotic Pest Plant Council (<http://www.fleppc.org/>)
 - Great Lakes Information Network (<http://www.great-lakes.net/>)
 - HYPPZ (<http://www.inra.fr/Internet/Produits/HYPPZ/pests.htm>): French Institut National de la Recherche Agonomique Pest Data Sheets.
 - International Association for the Plant Protection Sciences (<http://www.plantprotection.org/>)
 - International Survey of Herbicide Resistant Weeds (<http://www.weedscience.org/in.asp>)
 - Invasive Alien Plant Species of Virginia (<http://www.dcr.state.va.us/dnh/invproj.htm>)
 - IPPC 2006. International Plant Health Risk Analysis Workshop 24 - 28 October 2005, Niagara Falls, Canada (<https://www.ippc.int>)
 - IPPC Procedural Manual, 2006. Website: www.ippc.int/id/159891?language=en
 - Israel Journal of Plant Protection Sciences (<http://www.phytoparasitica.org>)
 - Ministry of Agriculture and Forestry, New Zealand (<http://www.maf.govt.nz/MAFnet/index.htm>)
 - NAPIS (<http://ceris.purdue.edu/napis/index.html>): The National Agricultural Pest Information System (U.S.), homepage for the database of the Cooperative Agriculture Pest Survey (CAPS) Program. Database access requires a password, but useful links exist.
 - National Association of State Departments of Agriculture (<http://www.nasdaq-hq.org/>)
 - New Pest Advisory Group (NPAG) (<http://www.cphst.org/NPAG/>)

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- North American Exotic Forest Pest Information System (<http://www.exoticforestpests.org/>): identifies exotic insects, mites and pathogens with potential to cause significant damage to North American forest resources. Sponsored by the North American Forest Commission.
 - PPQ Intranet, Need Access (<http://inside.aphis.usda.gov/ppq/>)
 - PPQ Plant Protection and Management Programs (PDMP) (http://www.aphis.usda.gov/plant_health/plant_pest_info/biosecurity/index.shtml)
 - Queensland Government (<http://www.nrm.qld.gov.au/>)
 - RiskWorld (<http://www.riskworld.com/>): Daily risk analysis in the news covering various areas, includes training opportunities.
 - ScaleNet (<http://www.sel.barc.usda.gov/scalenet/scalenet.htm>)
 - Secretariat of the Pacific Community Plant Protection Service (<http://www.spc.int/pps/Default.htm>)
 - Southeast Exotic Pest Plant Council (<http://www.se-eppc.org/>)
 - Systematic Botany and Mycology Laboratory (http://www.ars.usda.gov/main/site_main.htm?modecode=12-75-39-00)
 - Systematic Entomology Laboratory (<http://www.sel.barc.usda.gov/selhome/selhome.htm>)
 - Texas Department of Agriculture-Alerts: (http://www.agr.state.tx.us/agr/program_render/0,1987,1848_5411_0_0,00.html?channelId=5411)
 - Texas Parks and Wildlife (<http://www.tpwd.state.tx.us/>)
 - The World Conservation Union Invasive Species Specialist Group (<http://www.issg.org/>)
 - U.S. Department of State (<http://www.state.gov/>)
 - United States Department of Agriculture (USDA) Forest Service (<http://www.fs.fed.us/>)
 - United States Fish and Wildlife Services (<http://www.fws.gov/>)
 - United States Geological Survey (USGS) Nonindigenous Aquatic Species (NAS) (<http://nas.er.usgs.gov/>)
 - USDA Crop Profiles (<http://cipm.ncsu.edu/cropprofiles/>): This site is part of the effort by the USDA Pest Management Centers to provide information critical to pest management needs in the United States; subject focus is pesticide oriented
 - USDA Identifiers Website, Need Access (<http://inside.aphis.usda.gov/ppq/identifiers/INDEX.HTM>)
 - USDA PRA's (<http://www.aphis.usda.gov/ppq/pr/>): Provides guidelines, status of requests, and completed pest risk assessments.
 - USDA/APHIS/PPQ Manuals Unit (http://www.aphis.usda.gov/ppq/manuals/online_manuals.html)
 - USDA-ARS Germplasm Resources Information Network (GRIN) (<http://www.ars-grin.gov/npgs/tax/>)

- Wisconsin Department of Agriculture, Trade, and Consumer Protection (<http://datcp.state.wi.us/>)
- World Trade Organization: www.wto.org
- WTO on-line training course: www.wto.org/English/res_e/d_learn_e/d_learn_e.htm#sps
- WTO-SPS Agreement: www.wto.org/english/tratop_e/sps_e/sps_e.htm

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Organisms: Arthropods

Organisms: Arthropods - Online

- Bugwood Network (<http://www.bugwood.caes.uga.edu/entomology.html>)
- Catalog of the Lepidoptera of the French Antilles (<http://www.inra.fr/Internet/Produits/PAPILLON/indexeng.htm>): This catalogue presents all species of macrolepidoptera found in Martinique, Guadeloupe and their dependencies. It is mainly based on collections made by J. le Duchat'Aubigny and B. Lalanne-Cassou during their six years stay in Guadeloupe. Hosted by the French Institut National de la Recherche Agronomique.
- CBIF. 2003. Butterflies of Canada. Canadian Biodiversity Information Facility; http://www.cbif.gc.ca/spp_pages/butterflies/index_e.php
- Cerambycidae (<http://www.uochb.cas.cz/~natur/cerambyx/cerambyx.htm>): Contains a photo gallery of over 400 West Palaearctic species, with details on the biology and host plants of many. Includes useful literature citations.
- Coleoptera (<http://www.coleoptera.org/>): It's not clear who runs this website, but a lot of useful Coleopteran information is accessible here, including links to numerous databases.
- Electronic Resources on Coleoptera (<http://www.chebucto.ns.ca/Environment/NHR/coleoptera.html>)
- Entomological Society of America (<http://www.entsoc.org>)

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- Entomology Circulars (<http://www.doacs.state.fl.us/pi/enpp/ento/entocirc-no.htm>): Florida Dept. of Agriculture and Consumer Services
 - Entomology Index of Internet Resources (<http://www.ent.iastate.edu/List/>): A very comprehensive list of entomological links from Iowa State University. The database link is particularly useful (<http://www.ent.iastate.edu/List/databases.html>).
 - Entomotropica (<http://www.entomotropica.org/presentacion.php?LNG=2>): Free e-journal with particular relevance to the Caribbean. Three issues per year.
 - Florida Entomologist (<http://www.fcla.edu/FlaEnt/>)
 - Florida Entomologist (<http://www.flaentsoc.org/fe.html>): Free e-journal with particular relevance to the Caribbean. Four issues per year.
 - Hosts (<http://www.nhm.ac.uk/entomology/hostplants/>): A database of the hostplants of the world's Lepidoptera, hosted by the Natural History Museum, UK. This site offers a synoptic data set drawn from about 180,000 records comprising taxonomically "cleaned" hostplant data for about 22,000 Lepidoptera species drawn from about 1600 published and manuscript sources. It is not (and cannot be) exhaustive, but it is probably the best and most comprehensive compilation of hostplant data available.
 - HYPP Zoology (HYPPZ) homepage (<http://www.inra.fr/Internet/Produits/HYPPZ/pests.htm>)
 - Index of Pages of Butterflies and Moths of Australia (<http://www-staff.it.uts.edu.au/~don/larvae/larvae.html>)
 - Index of the Species of Florida Lepidoptera (<http://fsca-dpi.org/Lepidoptera/FloridaSpeciesIndex.htm>): From the Museum of Entomology, Florida State Collection of Arthropods.
 - Insect Pests of Micronesia (<http://www.crees.org/plantprotection/AubWeb/bugweb/bugroot.htm>)
 - Iowa State University Entomology Index of Internet Resources (<http://www.ent.iastate.edu/list/>)
 - Lepidopteran Web Links (<http://facweb.furman.edu/~snyderjohn/lepsoc/lepidop.htm>)
 - NominaInsectaNearctica (<http://www.nearctica.com/nomina/main.htm>): A checklist of the insects of North America. NominaInsectaNearctica is a complete synonymical checklist of the approximately 90,000 species of insects of North America north of Mexico published by Entomological Information Services in 1996 and 1997 in four volumes and a CD-ROM. Caveats: the web version omits synonyms; doesnot distinguish between presence in CA, US, or MX; and doesnot include references.
 - North American Non-indigenous Arthropod Database (NANIAD) (<http://www.invasivespecies.org/NANIAD.html>)
 - Pest Fruit Flies of the World (<http://www.sel.barc.usda.gov/Diptera/tephriti/tephriti.htm>): Descriptions, Illustrations, Identification, and Information Retrieval.

- ScaleNet (<http://www.sel.barc.usda.gov/scalenet/scalenet.htm>): A scale insect (Coccoidea) database which provides comprehensive information on the scale insects of the world, including queriable information on their classification, nomenclatural history, distribution, hosts, and literature. Cooperatively hosted by governmental agricultural research agencies in US, CA, and IL.
- Tephritidae (Fruit Flies) (<http://www.sel.barc.usda.gov/Diptera/tephriti/tephriti.htm>)
- The Beetles of the Virgin Islands (http://IRIS.biosci.ohio-state.edu:80/vi_beetles/): The V.I. beetle fauna project was started in 1978 by Michael A. Ivie of Montana State University, now includes many taxonomic and collecting cooperators. Currently contains 489 species (34,698 specimens), and can be queried by island, family, or specimen.
- University of Florida and FDOACS Featured Creatures (<http://creatures.ifas.ufl.edu/>)
- University of Florida Woodybug (<http://woodypest.ifas.ufl.edu/>)

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Organisms: Pathogens (bacteria, viruses, fungi, etc.)

Organisms: Pathogens (bacteria, viruses, fungi, etc.) - Online

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- All the Virology on the WWW
(<http://www.tulane.edu/~dmsander/garryfavweb.html>)
 - Berkley Xylella fastidiosa Web Site
(<http://www.cnr.berkeley.edu/xylella/index.html>)
 - Common Names of Plant Diseases (<http://www.apsnet.org/online/common/>) from the American Phytopathological Society website
 - Institute for Plant Diseases Plant Pathology Internet Guide Book
(<http://www.pk.uni-bonn.de/ppigb/ppigb.htm>)
 - List of Widely Prevalent Plant Pathogenic Fungi
(<http://www.aphis.usda.gov/ppq/permits/fungibyfungus.pdf>): from the US, a pdf file from APHIS, 2001.
 - Plant Virus Server/Information (<http://www.virology.net/garryfavwebplant.html>): Hotlinks to numerous plant virus resources.
 - Plant Viruses Online (<http://image.fs.uidaho.edu/vide/>): Excellent database from the University of Idaho covering multiple plant virus aspects.
 - Soybean Disease Atlas (<http://cipm.ncsu.edu/ent/SSDW/soyatlas.htm>): From the Southern Soybean Disease Workers (SSDW), an organization involved with soybean production and research in the southern U.S.
 - The American Phytopathological Society (APS): Plant Pathology/Disease Online (<http://www.apsnet.org/>)
 - The Plant Pathology Internet Guidebook (<http://www.pk.uni-bonn.de/ppigb/ppigb.htm>): This multi-disciplinary German website is a subject oriented internet resource guide for plant pathology, applied entomology, and all related fields.
 - University of California Cooperative Extension (UCCE) in Marin County Sudden Oak Death (<http://nature.berkeley.edu/comtf/>)
 - USDA Systematic Botany and Mycology Lab
(http://www.ars.usda.gov/main/site_main.htm?modecode=12-75-39-00): includes vascular plant and fungal databases
 - Viruses of Plants (<http://image.fs.uidaho.edu/vide/refs.htm#authors>): Descriptions and Lists from the VIDE Database, CAB International

Organisms: Pathogens (bacteria, viruses, fungi, etc.) - Print

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Organisms: Botany

- A Global Compendium of Weeds (<http://www.hear.org/gcw/>): A collaborative website from Agriculture Western Australia and USGS' Hawaii Ecosystems at Risk (HEAR) project. It contains references to approximately 20,000 taxa of plants, citing information about "weedy" characteristics of each, based on information in nearly 300 references.
- Agricultural Research Service (ARS) (<http://www.ars.usda.gov/>)
- Agriculture Research Service (ARS) Exotic and Invasive Weeds Research Unit (<http://www.nps.gov/plants/alien/list/a.htm>)
- APHIS Federal Noxious Weed List (<http://www.aphis.usda.gov/ppq/permits/fnwsbycat-e.PDF>)
- Aquatic Plants (Life of Amazonia, Plants) (<http://www.amazonian-fish.co.uk/>)
- ARS Magazine (<http://www.ars.usda.gov/is/AR/>)
- Atlas of Florida Vascular Plants online Database (<http://www.plantatlas.usf.edu>)
- BONAP (<http://www.bonap.org/>): Biota Of North America Project (BONAP) includes data for all vascular plants and vertebrate species (native, naturalized, and adventive) of North America, north of Mexico.
- Center for Aquatic and Invasive Plants: (<http://plants.ifas.ufl.edu/>)
- Center for Invasive Plant Management (CIPM) (<http://www.weedcenter.org/index.html>)

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- Croplife America (<http://www.croplifeamerica.org/>)
 - CropMAP (<http://www.hort.purdue.edu/newcrop/cropmap/>): U.S. crop distributions and hardiness zones by county.
 - Database of IPM Resources (DIR) (<http://www.ippc.orst.edu/cicp/gateway/weed.htm>)
 - Flora Europaea (<http://rbg-web2.rbge.org.uk/FE/fe.html>): From the Royal Botanic Garden in Edinburgh, the flora of Europe as extracted from the digital version of the Flora Europaea.
 - FloraBase (<http://florabase.calm.wa.gov.au/>): Information on the flora of Western Australia
 - Food and Agriculture Organization of the United Nations (<http://www.fao.org/>)
 - Fundecitrus- Fund for Citrus Plant Protection (<http://www.fundecitrus.com.br/>)
 - GRIN Taxonomy (<http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl>): USDA Germplasm Resources Information Network (GRIN) taxonomic data provide the structure and nomenclature for the accessions of the National Plant Germplasm System (NPGS). Many plants (37,000 taxa, 14,000 genera) are included in GRIN taxonomy, especially economic plants.
 - HEAR, a Global Compendium of Weeds and the Hawaii/Pacific Islands Ecosystems at Risk Websites (<http://www.hear.org/index.html>; <http://www.hear.org/pier/index.html>)
 - Internet Directory for Botany (<http://www.botany.net/IDB/>): A compendium for plant related websites, it comes highly recommended.
 - Invaders Database System (<http://invader.dbs.umt.edu/>)
 - Missouri Botanical Garden (<http://www.mobot.org/>)
 - National Agricultural Statistics Service (<http://www.nass.usda.gov/index.asp>)
 - NewCROPhomepage (<http://newcrop.hort.purdue.edu/newcrop/default.html>)
 - North Carolina Botanical Garden (<http://www.ncbg.unc.edu/>)
 - North Carolina State University (NCSU) Department of Botany Herbarium (<http://www.cals.ncsu.edu/botany/ncsc/>)
 - Plant Conservation Alliance's (PCA) Alien Plant Working Group (APWG) Alien Plant Invaders of Natural Areas (<http://www.nps.gov/plants/alien/list/a.htm>)
 - Plant Protection and Quarantine (PPQ) Federal Noxious Weed Program (<http://www.aphis.usda.gov/ppq/weeds/nwpolicy2001.html>)
 - Plants Database (<http://plants.usda.gov/>): The PLANTS Database (USDA) is a single source of standardized information about plants, focusing on vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories. The database includes names, checklists, automated tools, identification information, species abstracts, distributional data, crop information, plant symbols, plant growth data, plant materials information, plant links, references, and other plant information.
 - Radcliffe's IPM World Textbook (<http://ipmworld.umn.edu/>)
 - Soybean Disease Atlas (<http://cipm.ncsu.edu/ent/SSDW/soyatlas.htm>)

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- The National Agricultural Library (<http://www.nal.usda.gov/>)
 - The National Center for Food and Agricultural Policy (NCFAP) (<http://pestdata.ncsu.edu/ncfap/search.cfm>)
 - The New York Botanical Garden Vascular Plant Types Database (<http://www.nybg.org/bsci/hcol/vasc/>)
 - Tropical Fruit Index (<http://www.proscitech.com.au/trop/link.htm>)
 - U.S. Federal Noxious Weeds (http://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/index.shtml): USDA's published list of federally regulated (quarantine) weeds. Other related links are also available.
 - University of Minnesota Plant Information Online, Password required (<http://plantinfo.umn.edu/arboretum/default.asp>)
 - US Army Corps of Engineers Weed Database (<http://www.saj.usace.army.mil/conops/apc/newtt/cat1maps/database.htm>)
 - USDA Economic Research Service (ERS)-State Fact Sheets (<http://www.ers.usda.gov/statefacts/>)
 - USDA homepage: (<http://www.usda.gov/news/pubs/fbook98/content.htm>)
 - USDA Systematic Botany and Mycology Lab (http://www.ars.usda.gov/main/site_main.htm?modecode=12-75-39-00): includes vascular plant and fungal databases
 - Weed Science Society of America (<http://www.wssa.net/>)
 - Weeds Gone Wild (<http://www.nps.gov/plants/alien/>)

Organisms: Molluscs

Organisms: Molluscs – Online

- Bishop Museum (<http://www.bishopmuseum.org/research/natsci/mala/>): Contains Hawaiian checklists.
- The Malacological Society of London (<http://www.malacsoc.org.uk/>): Various Molluscan information.
- Malacology Collection Database (<http://www.flmnh.ufl.edu/databases/mala/intro.htm>): The Florida Museum of Natural History houses the major malacology collection in the southeastern USA. Presently the collection contains about 340,000 specimen-lots.
- Michigan State University Snail Laboratory (<http://www.msu.edu/~atkinso9/>)
- Molluscan Pictures (<http://www.molluscan.com/>)
- Giant African Land Snail Website (<http://www.geocities.com/Heartland/Valley/6210/>)
- American Malacological Society (<http://erato.acnatsci.org/ams/>)

Organisms: Molluscs – Print

Barker, G.M. (ed.). 2001. The Biology of Terrestrial Molluscs. Wallingford, U.K.: CABI Publ.

Barker, G.M. (ed.). 2002. *Molluscs as Crop Pests*. Wallingford, U.K.: CABI Publ.
Bishop Museum. Hawaiian Alien Snail Database. Honolulu: B.P. Bishop Museum;
<http://hbs.bishopmuseum.org/aliensnailsearch.html>

Organisms: Nematodes

Organisms: Nematodes – Online

- Accueil Laboratory of Nematology (<http://www.rennes.inra.fr/>)
- Insect Parasitic Nematodes (<http://www2.oardc.ohio-state.edu/nematodes/>)
- Nematode Common Names (<http://www.barc.usda.gov/psi/nem/common.htm>): USDA database of common and scientific names of nematodes.
- ONTA (<http://onta.ifas.ufl.edu/index.html>): Organization of Nematologists of Tropical America.
- Pest List Project (<http://nematode.unl.edu/pesttables.htm>): The Society of Nematologists list of the top pest threats to North America, with very good data sheets.
- Phytoparasitic Nematodes Reported from Florida (<http://www.doacs.state.fl.us/pi/enpp/nema/images/phyotnema.pdf>): a pdf file from December 2002.
- Plant and Insect Parasitic Nematodes (<http://nematode.unl.edu/>): University of Nebraska- Lincoln website on nematodes.
- University of Nebraska-Lincoln- Nematodes of Quarantinable Concern (<http://nematode.unl.edu/quaranem.htm>)
- USDA Nematology Lab (<http://www.barc.usda.gov/psi/nem/home-pg.html>): Useful links, collection and database, and other nematological information.
- USDA Nematology Lab homepage (<http://www.barc.usda.gov/psi/nem/home-pg.html>)

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- Anonymous. 1984. *Distribution of Plant-Parasitic Nematode Species in North America*. Society of Nematologists.
- Barker, K.R., G.A. Pederson, and G.L. Windham (eds.). 1998. *Plant and Nematode Interactions*. Madison, WI: Am. Soc. Agron./Crop Sci. Soc. Am./Soil Sci. Soc. Am.
- Evans, K., D.L. Trudgill, and J.M. Webster (eds.). 1993. *Plant Parasitic Nematodes in Temperate Agriculture*. Wallingford, U.K.: CAB International.
- Luc, M., R.A. Sikora, and J. Bridge. 1990. *Plant Parasitic Nematodes in Subtropical and Tropical Agriculture*. Wallingford, U.K.: CAB International.
- Nematological abstracts. St. Albans, England : Commonwealth Agricultural Bureaux.
Nickle, W.R. (ed.). 1991. *Manual of Agricultural Nematology*. New York: Marcel Dekker.

USDA Plant Hardiness Zone Maps

- Africa: <http://www.geocities.com/westcornersville/africazones.gif>

- Australia: <http://www.anbg.gov.au/hort.research/zones.html>
- China: <http://www.backyardgardener.com/zone/china.html>
- Europe: <http://www.backyardgardener.com/zone/europe1zone.html>
- North America: <http://www.usna.usda.gov/Hardzone/ushzmap.html>
- South America: <http://www.geocities.com/westcornersville/sazones.gif>
- Turkey/Black Sea region: <http://www.geocities.com/westcornersville/turzones.gif>
- Ukraine: <http://www.ars.usda.gov/Main/docs.htm?docid=9815&page=3>

Disease Compendium Series (American Phytopathological Society)

- Caruso, F.L. and D.C. Ramsdell (eds.). 1995. *Compendium of Blueberry and Cranberry Diseases*. St. Paul, MN: APS Press.
- Chase, A.R. 1987. *Compendium of Ornamental Foliage Plant Diseases*. St. Paul, MN: APS Press.
- Clark, C.A. and J.W. Moyer. 1988. *Compendium of Sweet Potato Diseases*. St Paul, MN: APS Press.
- Daughtrey, M.L., R.L. Wick, and J.L. Peterson. 1995. *Compendium of Flowering Potted Plant Diseases*. St. Paul, MN: APS Press.
- Davis, R.M. and R.N. Raid (eds.). 2002. *Compendium of Umbelliferous Crop Diseases*. St. Paul, MN: APS Press.
- Davis, R.M., K.V. Subbarao, R.N. Raid, and E.A. Kurtz. 1997. *Compendium of Lettuce Diseases*. St. Paul, MN: APS Press.
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- Horst, R.K. (prep.). 1983. *Compendium of Rose Diseases*. St. Paul, MN: APS Press.
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- Jones, A.L. and H.S. Aldwinckle (eds.). 1990. *Compendium of Apple and Pear Diseases*. St. Paul, MN: APS Press.
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- Ogawa, J.M., E.I. Zehr, G.W. Bird, D.F. Ritchie, K. Uriu, and J.K. Uyemoto (eds.). 1995. *Compendium of Stone Fruit Diseases*. St. Paul, MN: APS Press.
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