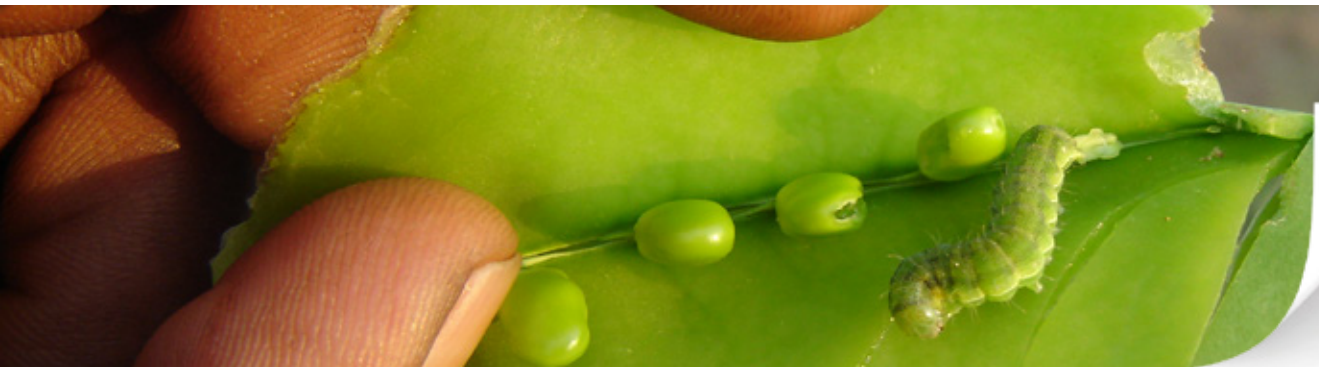
TRAINING MANUAL

- PLANT HEALTH -

MONITORING OF HARMFUL ORGANISMS AND ASSESSMENT OF PHYTOSANITARY RISKS



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MONITORING OF HARMFUL ORGANISMS AND ASSESSMENT OF PHYTOSANITARY RISKS

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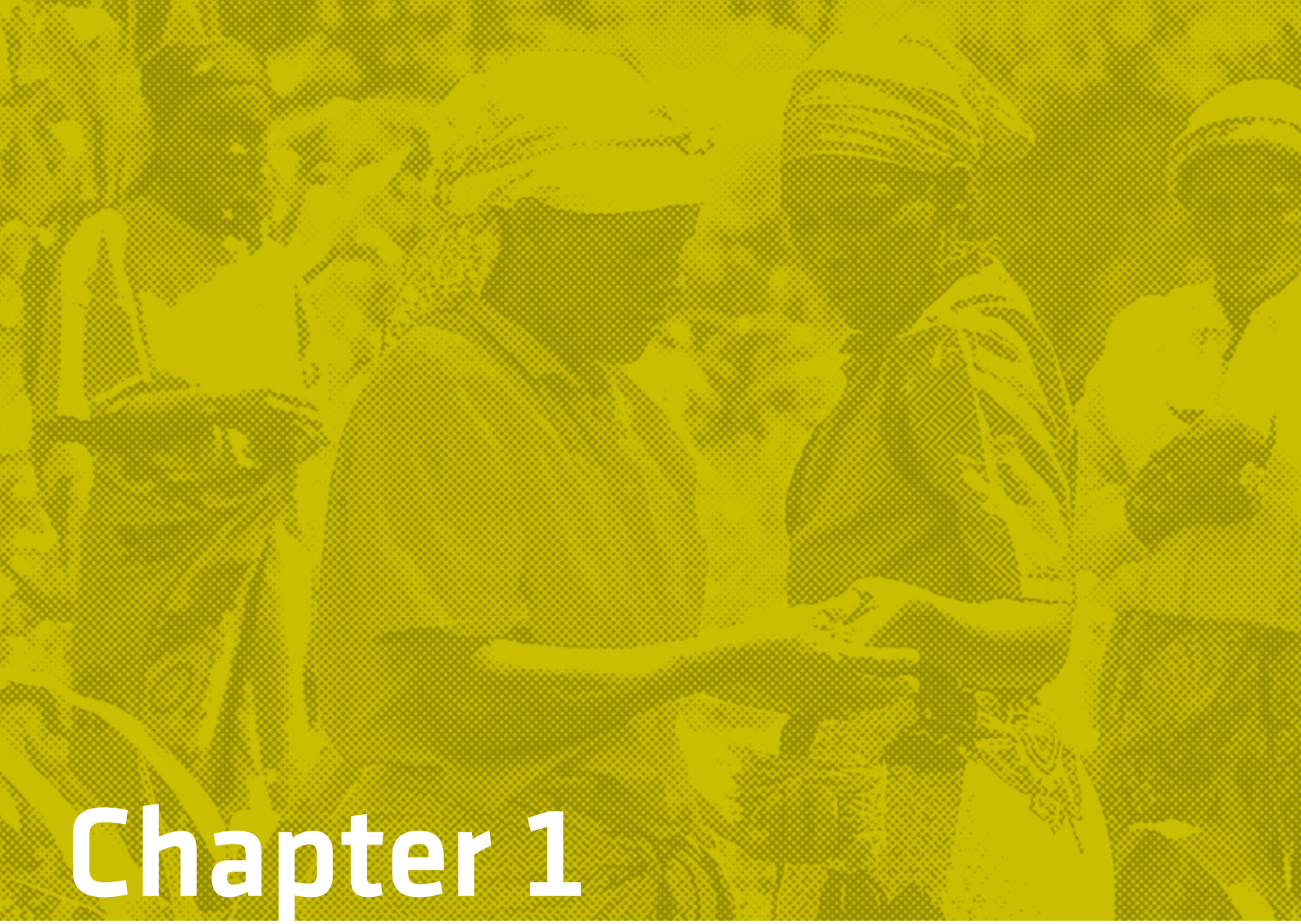

Chapter 1

Introduction to plant health, phytosanitary principles and application of phytosanitary measures

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1.1. Introduction

This chapter is based on the text of ISPM No. 1.

ISPM No. 1 was first endorsed by the 27th Session of the FAO Conference in November 1993 as: Principles of plant quarantine as related to international trade. The first revision was endorsed by the Commission on Phytosanitary Measures in April 2006 as the present standard, ISPM No. 1 (2006).

1.1.1. Introduction scope

This standard describes phytosanitary principles for the protection of plants that are embodied in the **International Plant Protection Convention (IPPC)** and elaborated in its International Standards for Phytosanitary Measures. It covers principles related to the protection of plants, including cultivated and non-cultivated/unmanaged plants, wild flora and aquatic plants, those regarding the application of phytosanitary measures to the international movement of people, commodities and conveyances, as well as those inherent in the objectives of the IPPC. The standard does not alter the IPPC, extend existing obligations, or interpret any other agreement or body of law.

1.1.2. References

Agreement on the Application of Sanitary and Phytosanitary Measures, 1994, World Trade Organization, Geneva.
Glossary of phytosanitary terms, 2006, ISPM No. 5, FAO, Rome.
International Plant Protection Convention, 1997, FAO, Rome.
All International Standards for Phytosanitary Measures.

1.1.3. Definitions

Definitions of phytosanitary terms used in the present standard can be found in ISPM No. 5 (Glossary of phytosanitary terms).

1.1.4. Outline of requirements

This standard describes the following basic principles under the IPPC: sovereignty, necessity, managed risk, minimal impact, transparency, harmonization, non-discrimination, technical justification, cooperation, equivalence of phytosanitary measures and modification. This standard also describes the operational principles under the IPPC, which are related to the establishment, implementation and monitoring of phytosanitary measures, and to the administration of official phytosanitary systems. The operational principles are: pest risk analysis, pest listing, recognition of pest free areas and areas of low pest prevalence, official control for regulated pests, systems approach, surveillance, pest reporting, phytosanitary certification, phytosanitary integrity and security of

consignments, prompt action, emergency measures, provision of a National Plant Protection Organization, dispute settlement, avoidance of undue delays, notification of non-compliance, information exchange and technical assistance.

1.2. Context

The original version of ISPM No. 1 (Principles of plant quarantine as related to international trade) was endorsed as a reference standard by the 27th Session of FAO Conference in 1993. It was developed at the time the Agreement on the Application of Sanitary and Phytosanitary Measures of the World Trade Organization (SPS Agreement) was being negotiated. It helped to clarify some of the elements of the SPS Agreement which were under discussion at that time. The SPS Agreement was adopted in April 1994, and experience has been gained since then on its practical application in relation to phytosanitary measures. The new revised text of the IPPC was adopted by FAO Conference in 1997. It includes many changes to the 1979 version of the Convention. The revision of the IPPC in 1997 has meant that ISPM No. 1 required revision. In addition to the SPS Agreement, other international conventions exist which also directly or indirectly deal with the protection of plants. This standard aims to aid in the understanding of the IPPC and provides guidance on the fundamental elements in phytosanitary systems. The principles described below reflect key elements of the IPPC. In some cases, additional guidance on these elements is provided. The standard should be interpreted in accordance with the full text of the IPPC. Quotations from the IPPC are indicated in quotation marks and italics.

1.3. Principles

These principles are related to the rights and obligations of contracting parties to the IPPC. They should be considered collectively, in accordance with the full text of the IPPC, and not interpreted individually.

1.3.1. Basic principles

❑ Sovereignty

Contracting parties have sovereign authority, in accordance with applicable international agreements, to prescribe and adopt phytosanitary measures to protect plant health within their territories and to determine their appropriate level of protection for plant health.

In relation to phytosanitary measures, the IPPC provides that:

"With the aim of preventing the introduction and/or spread of regulated pests into their territories, contracting parties shall have sovereign authority to regulate, in accordance with applicable international agreements, the entry of plants and plant products and other regulated articles and, to this end, may:

a) prescribe and adopt phytosanitary measures concerning the importation of plants, plant products and other regulated articles, including, for example, inspection, prohibition on importation, and treatment;
b) refuse entry or detain, or require treatment, destruction or removal from the territory of the contracting party, of plants, plant products and other regulated articles or consignments thereof that do not comply with the phytosanitary measures prescribed or adopted under subparagraph (a);
c) prohibit or restrict the movement of regulated pests into their territories;
d) prohibit or restrict the movement of biological control agents and other organisms of phytosanitary concern claimed to be beneficial into their territories"
(Article VII.1).

In exercising this authority, and "In order to minimize interference with international trade, [...]" (Article VII.2) each contracting party undertakes to act in conformity with the provisions of Article VII.2 of the IPPC.

❑ Necessity

Contracting parties may apply phytosanitary measures only where such measures are necessary to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests. In this regard, the IPPC provides that: "*Contracting parties shall not, under their phytosanitary legislation, take any of the measures specified in [...] unless such measures are made necessary by phytosanitary considerations [...]*" (Article VII.2a). Article VI.1b states that "*Contracting parties may require phytosanitary measures for quarantine pests and regulated non-quarantine pests, provided that such measures are [...] limited to what is necessary to protect plant health [...]*". Article VI.2 states that "*Contracting parties shall not require phytosanitary measures for non-regulated pests*".

❑ Managed risks

Contracting parties should apply phytosanitary measures based on a policy of managed risk, recognizing that risk of the spread and introduction of pests always exists when importing plants, plant products and other regulated articles. Contracting parties *"[...] shall institute only phytosanitary measures that are [...] consistent with the pest risk involved [...]*" (Article VII.2g).

❑ Minimal impact

Contracting parties should apply phytosanitary measures with minimal impact. In this regard, the IPPC provides that they *"[...] shall institute only phytosanitary measures that [...] represent the least restrictive measures available, and result in the minimum impediment to the international movement of people, commodities and conveyances*" (Article VII.2g).

❑ Transparency

Contracting parties shall make relevant information available to other contracting parties as set forth in the IPPC. In this regard, the IPPC states that, for example:

- *"[...] contracting parties shall, immediately upon their adoption, publish and transmit phytosanitary requirements, restrictions and prohibitions to any contracting party or parties that they believe may be directly affected by such measures"* (Article VII.2b).
- "*Contracting parties shall, on request, make available to any contracting party the rationale for phytosanitary requirements, restrictions and prohibitions"* (Article VII.2c).
- *"The contracting parties shall ... cooperate in the exchange of information on plant pests [...]"* (Article VIII.1 & 1a).
- *"Contracting parties shall, to the best of their ability, establish and update lists of regulated pest [...] and make such lists available [...]"* (Article VII.2i).
- *"Contracting parties shall, to the best of their ability [...] develop and maintain adequate information on pests status [...] This information shall be made available [...]"* (Article VII.2j).

❑ Harmonization

Contracting parties should cooperate in the development of harmonized standards for phytosanitary measures. In this regard, the IPPC provides that *"The contracting parties agree to cooperate in the development of international standards [...]"* (Article X.1). Contracting parties *should [...] related to this Convention"* (Article X.4). *"The contracting parties shall encourage any state or member organization of FAO, not a party to this convention [...] to apply phytosanitary measures consistent with the provisions of this Convention and any international standards adopted hereunder"* (Article XVIII).

❑ Non-discrimination

Contracting parties should, in accordance with the IPPC, apply phytosanitary measures without discrimination between contracting parties if contracting parties can demonstrate that they have the same phytosanitary status and apply identical or equivalent phytosanitary measures.

Contracting parties should also apply phytosanitary measures without discrimination between comparable domestic and international phytosanitary situations.

In these regards, the IPPC provides that:

- phytosanitary measures *"[...] should not be applied in such a way as to constitute either a means of arbitrary or unjustified discrimination or a disguised restriction, particularly on international trade"* (Preamble).
- contracting parties may require phytosanitary measures, provided that such measures are *"[...] no more stringent than measures applied to the same pests, if present within the territory of the importing contracting party"* (Article VI.1a).

❑ Technical justification

Contracting parties shall technically justify phytosanitary measures *"[...] on the basis of conclusions reached by using an appropriate pest risk analysis or, where applicable, another comparable examination and evaluation of available scientific information"* (Article II.1). In this regard, the IPPC provides that *"Contracting parties shall not, under their phytosanitary legislation, take any of the measures specified in paragraph 1 of this Article (VII) unless such measures [...] are technically justified"* (Article VII.2a). Article VI.1b also refers to technical justification. Phytosanitary measures which conform to ISPMs are deemed to be technically justified.

❑ Cooperation

Contracting parties should cooperate with one another to achieve the objectives of the IPPC. In particular, they *"[...] shall cooperate with one another to the fullest practicable extent in achieving the aims of [the] Convention [...]"* (Article VIII). Contracting parties should also actively participate in bodies established under the IPPC.

❑ Equivalence of phytosanitary measures

Importing contracting parties should recognize alternative phytosanitary measures proposed by exporting contracting parties as equivalent when those measures are demonstrated to achieve the appropriate level of protection determined by the importing contracting party.

Relevant ISPM: No. 24.

❑ Modification

Modifications of phytosanitary measures should be determined on the basis of a new or updated pest risk analysis or relevant scientific information. Contracting parties should not arbitrarily modify phytosanitary measures. *"Contracting parties shall, as conditions change, and as new facts become available, ensure that phytosanitary measures are promptly modified or removed if found to be unnecessary"* (Article VII.2h).

1.3.2. Operational principles

Operational IPPC principles are related to the establishment, implementation and monitoring of phytosanitary measures, and to the administration of official phytosanitary systems.

❑ Pest risk analysis

National Plant Protection Organizations (NPPOs) should, when performing pest risk analysis, base it on biological or other scientific and economic evidence, following the relevant ISPMs. In doing this, threats to biodiversity resulting from effects on plants should also be taken into account.

Relevant Articles in the IPPC: Preamble, Articles II, IV.2f and VII.2g.
Relevant ISPMs: No 2, No. 5 (including supplement No. 2), No. 11 and No. 21.

❑ Pest listing

Contracting *parties "[…] shall, to the best of their ability, establish and update lists of regulated pests […]"* (Article VII.2i).

Relevant Articles in the IPPC: VII.2i.
Relevant ISPMs: No. 19.

❑ Recognition of pest free areas and areas of low pest prevalence

Contracting parties should ensure that their phytosanitary measures concerning consignments moving into their territories take into account the status of areas, as designated by the NPPOs of the exporting countries. These may be areas where a regulated pest does not occur or occurs with low prevalence or they may be pest free production sites or pest free places of production.

Relevant articles in the IPPC: II.
Relevant ISPMs: No. 4, No. 8, No. 10 and No. 22.

❑ Official control for regulated pests

When a pest which is present in a country is regulated as a quarantine pest or regulated non-quarantine pest, the contracting party should ensure that the pest is being officially controlled.

Relevant ISPM: ISPM No. 5 (including supplement No. 1).

❑ System approach

Integrated measures for pest risk management, applied in a defined manner, may provide an alternative to single measures to meet the appropriate level of phytosanitary protection of an importing contracting party.

Relevant ISPM: No. 14.

❑ Surveillance

Contracting parties should collect and record data on pest occurrence and absence to support phytosanitary certification and the technical justification of their phytosanitary measures. In this regard, the IPPC also provides that *"Contracting parties shall, to the best of their ability, conduct surveillance for pests and develop and maintain adequate information on pest status in order to support categorization of pests, and for the development of appropriate phytosanitary measures"* (ArticleVII.2j).

Relevant Articles in the IPPC: IV.2b, IV.2e and VII.2j.
Relevant ISPMs: No. 6 and No. 8.

❑ Pest reporting

Contracting parties *"[…] shall cooperate […] to the fullest practicable extent in […]. the reporting of the occurrence, outbreak or spread of pests that may be of immediate or potential danger […]"* to other contracting parties (Article VIII.1a). In this respect, they should follow the procedures established in ISPM No. 17 and other relevant procedures.

Relevant Article in the IPPC: VIII.1a.
Relevant ISPM: No. 17.

❑ Phytosanitary certification

Contracting parties should exercise due diligence in operating an export certification system and ensuring the accuracy of the information and additional declarations contained in phytosanitary certificates. *"Each contracting party shall make arrangements for phytosanitary certification […]"* (Article V).

Relevant Articles in the IPPC: IV.2a and V.
Relevant ISPMs: No. 7 and No. 12.

❑ Phytosanitary integrity and security of consignments

In order to maintain the integrity of consignments after certification, contracting parties, through their NPPO, shall "ensure through appropriate procedures that the phytosanitary security of consignments after certification regarding composition, substitution and reinfestation is maintained prior to export" (Article IV.2g).

Relevant Articles in the IPPC: IV.2g and V.
Relevant ISPMs: No. 7 and No. 12.

❑ Prompt action

Contracting parties should ensure that inspection or other phytosanitary procedures required at import *"[…] shall take place as promptly as possible with due regard to […] perishability"* of the regulated article (Article VII.2e).

Relevant Article in the IPPC: VII.2e.

❑ Emergency measures

Contracting parties may adopt and/or implement emergency actions, including emergency measures, when a new or unexpected phytosanitary risk is identified.[1] Emergency measures should be temporary in their application. The continuance of the measures should be evaluated by pest risk analysis or other comparable examination as soon as possible, to ensure that the continuance of the measure is technically justified.

Relevant Article in the IPPC: VII.6.
Relevant ISPM: No. 13.

❑ Provision of a NPPO

''Each contracting party shall make provision, to the best of its ability, for an official national plant protection organization with the main responsibilities set out in [Article IV.1]" (Article IV.1).

Relevant Article in the IPPC: IV.

❑ Dispute settlement

Contracting parties should be open to consultation regarding their phytosanitary measures, when requested by other contracting parties. If there is a dispute regarding the interpretation or application of the IPPC or its ISPMs, or if a contracting party considers that an action by another contracting party is in conflict with the obligations of the IPPC or guidance provided in its ISPMs, *"[…] the contracting parties concerned shall consult among themselves as soon as possible with a view to resolving the dispute"* (Article XIII.1). If the dispute cannot be resolved in this way, then the provisions of Article XIII relating to the settlement of disputes or other means of dispute settlement may be applied.[2]

Relevant Article in the IPPC: XIII.

❑ Avoidance of undue delays

When a contracting party requests another contracting party to establish, modify or remove phytosanitary measures, when conditions have changed or new facts have become available, this request should be considered without undue delay. Associated procedures, which include, but are not limited to, pest risk analysis, recognition of pest free areas or recognition of equivalence, should also be performed promptly.

Relevant Article in the IPPC: VII.2h.
Relevant ISPM: No. 24 (section 2.7 and annex I, step 7).

❑ Notification of non-compliance

Importing contracting *parties "[…] shall, as soon as possible, inform the exporting contracting party concerned […] of significant instances of non-compliance with phytosanitary certification"* (Article VII.2f).

Relevant Article in the IPPC: VII.2f.
Relevant ISPM: No. 1.

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1 The term emergency actions in Article VII.6 of the IPPC is interpreted to include emergency measures as defined in ISPM No. 5.

2 A non-binding dispute settlement procedure has been developed by the IPPC for use by the contracting parties.

❑ Information exchange

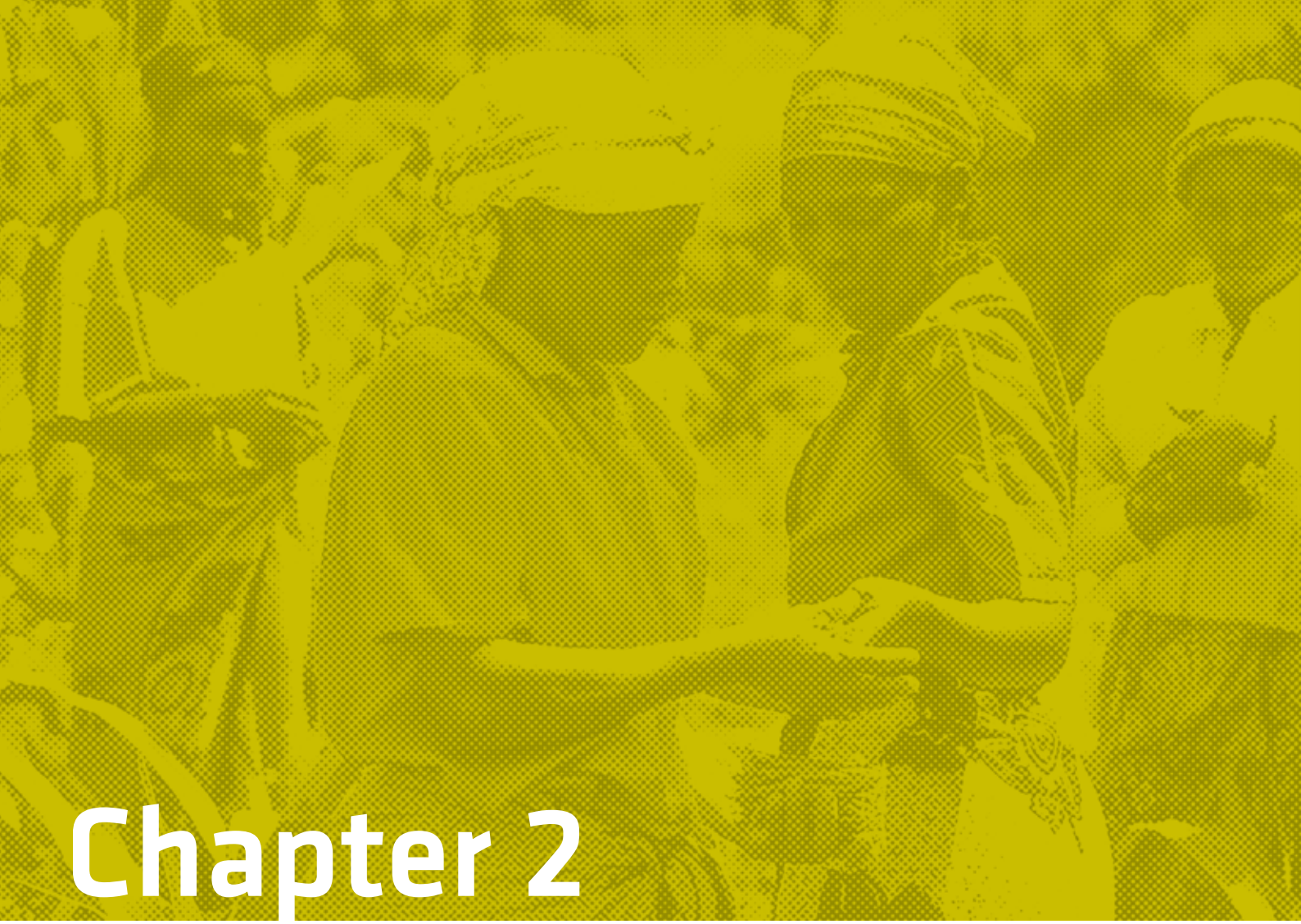
Contracting parties shall, as appropriate, provide information specified in the IPPC, as follows:

- Official contact points (Article VIII.2)
- Description of the NPPO and organizational arrangements of plant protection (Article IV.4)
- Phytosanitary requirements, restrictions and prohibitions (Article VII.2b) (including specified points of entry
- Article VII.2d) and their rationale (Article VII.2c)
- List of regulated pests (Article VII.2i)
- Pest reporting, including occurrence, outbreak and spread of pests (Articles IV.2b and VIII.1a)
- Emergency actions (Article VII.6) and non-compliance (Article VII.2f)
- Pest status (Article VII.2j)
- Technical and biological information necessary for pest risk analysis (to the extent practicable) (Article VIII.1c).

❑ Technical assistance

Contracting parties *"[…] agree to promote the provision of technical assistance to contracting parties, especially those that are developing contracting parties […] with the objectives of facilitating the implementation of the Convention"* (Article XX).

Relevant Article in the IPPC: XX.



Chapter 2

The major harmful organisms (including quarantine pests)

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2.1. Introduction

The European Union is adopting measures to protect itself against the introduction and spread of organisms harmful to plants and plant products from other Member States or third countries. It is also providing for control measures and the creation of the protective zones. The **control of harmful organisms within the Community** is an important part of the Community plant health regime.

The harmful organisms which may be targeted by specific control measures are either:

- Harmful organisms which are **found within** the Community for the first time; or
- Harmful organisms which are **found in Member States' territory** where their presence was previously unknown; or
- Other harmful organisms **previously unknown to occur in the Community**, which are not listed specifically but which are of **potential economic importance**.

Member States have an obligation to notify the Commission and other Member States of the presence within their territory of these harmful organisms and are obliged to take measures to eradicate or, if this is not possible, prevent the spread of the harmful organism concerned.

Where a Member State considers there is an imminent danger of introduction or spread of a harmful organism, it should **notify the Commission and other Member States** of the measures it would like to see taken and may temporarily take additional measures. Where the danger comes from consignments of plants, plant products or other objects originating in third countries, the Member State must immediately take action to protect the territory of the Community from that danger, and inform the Commission and other Member States thereof. Temporary (emergency) measures may be taken by the Community in these cases.

The Commission has an **obligation** to examine the situation as soon as possible (through the **Standing Committee on Plant Health)** and Community control measures are adopted.

2.2. Protection against organisms harmful to plant and plants products in the European Union

The protective measures, against the introduction of organisms harmful to plants or plant products and against their spread, are laid down in the **Council Directive** 2000/29/EC**.**

This Directive lays down measures designed to protect Member States **against the introduction of organisms harmful to plants and plant products** from other Member States or third countries.

This Directive also lays down measures designed to protect Member States against the spread of harmful organisms within the European Union. The protective measures relate to the means by which plants, plant products and other related items are moved (packaging, vehicles, etc.), and also cover the movement of plants and plant products between the European Union and some of its outermost regions, namely the French overseas departments and the Canary Islands.

The Directive covers **living plants** and **living parts of plants**, including **seeds**. Living parts of plants are:

- fruit and vegetables that have not been deep-frozen,
- tubers, corms, bulbs, rhizomes,
- cut flowers,
- cut trees and branches with foliage,
- leaves,
- live pollen,
- grafts and any other part of a plant.

Plant products are products of plant origin, unprocessed or having undergone simple preparation, other than the items listed above. Wood as such is also covered in some cases.

'**Harmful organisms**', as defined by the Directive, means **pests of plants** or of plant products, which belong to the animal or plant kingdoms, or which are pathogens. This definition covers in particular insects and mites, bacteria, fungi, viruses and parasite plants.

Annexes I and II list the harmful organisms banned in the European Union, either altogether or when they are on certain plants or plant products.

Annex III lists plants and plant products that must not be imported from certain countries.

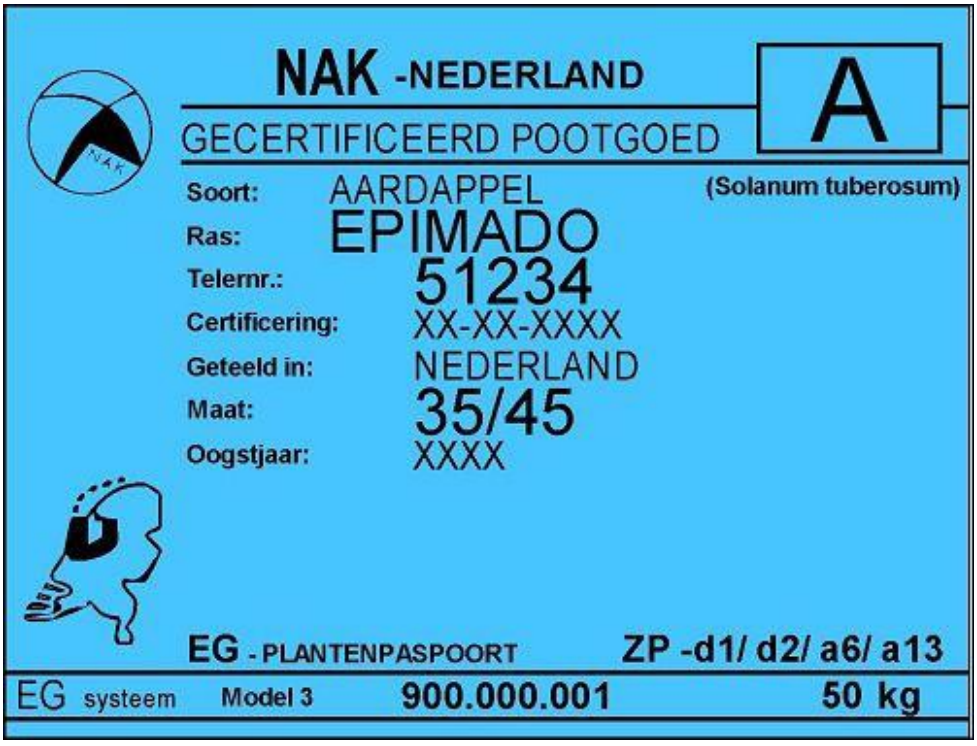
2.2.1. Placing on the market and intra-community trade

This Directive requires certain plants and plant products (**Annex V, part A**) to undergo a **plant-health inspection**.

This inspection must take place at least once a year at the place of production, at appropriate times, *i.e.* during the growth period or just after harvesting. It applies to plants and plant products at the production site and their growing environment.

Producers must be listed on an official register held by the national body responsible.

Exemptions may be granted for products for the local market if there is no risk of the harmful organism spreading. When the check gives satisfactory results, the national body responsible delivers a '**plant passport**' attesting compliance with Community plant-health rules. This passport is usually in the form of a standard label to be affixed to the product, its packaging or sometimes the vehicle in which it is transported. The passport may be replaced in certain circumstances (change of plant health status, division into batches etc.) and subject to certain conditions.



Plant passport (The Netherlands) – Potatoes

Where the results of a check are not satisfactory, the plants, plant products and growing media concerned may be subject to **various measures such as appropriate treatment** (if this is successful, the passport is then issued), movement under official control, or destruction. The Member States must also notify the Commission and the other Member

States of the presence of harmful organisms or the risk of their entering or spreading on their territory.

In addition to plant-health inspection, Member States are to organize occasional checks, whether at the place where plants or plant products are grown, produced, stored, offered for sale or moved, or at the same time as any other documentary check which is carried out for reasons other than plant health.

2.2.2. Imports from third countries

This Directive subjects certain plants and plant products from other countries (**Annex V, part B**) to a check on entry into European Union territory.

This involves a **documentary check**, an **identity check** and a **plant-health check**:

- The **documentary check** consists in checking certificates and documents accompanying the consignment or batch, in particular the plant-health certificate. This is issued by the authority responsible in the country of origin or re-export, using models drawn up by the Commission. It has to certify that the products have undergone appropriate and satisfactory inspections.
- The **identity check** involves checking that the consignment tallies with the plants or plant products covered by the certificate.
- The **plant-health check** involves checking, on the basis of a complete examination or an examination of samples, that the plants or plant products show no signs of contamination by harmful organisms and that they meet the specific requirements defined in this Directive.

The Directive provides for less stringent identity and plant-health checks where certain guarantees are provided. It also provides for **exemptions** where there is no risk of harmful organisms spreading, in particular in the following cases:

- Where plants or plant products are merely **in transit** from one point in the EU territory to another via a third country or from a point in one non-EU country to a point in another non-EU country via EU territory;
- Where **small quantities** of plants or plant products are not intended for industrial or commercial purposes or are to be consumed during transport are involved;
- Where plants or plant products are intended **for trials or scientific purposes** and for work on varietal selections;
- Where plants or plant products are grown, produced or used in the **immediate frontier zone** between a Member State and a third country.

Importers of certain plants or plant products (**Annex V**) must be on their Member State's official register.

If the results of the checks are satisfactory, instead of a **phytosanitary certificate**, a passport is delivered and the rules applicable to intra-Community movement are followed.

Example of a 'Phytosanitary Certificate' (*Source: Council Directive 2000/29/EC, eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:169:0001:0112:EN:PDF*)

1 Nom et adresse de l'expéditeur	**2** **CERTIFICAT PHYTOSANITAIRE** **N° CE / /**
3 Nom et adresse déclarés du destinataire	**4** Organisation de la protection des végétaux de à Organisation(s) de la protection des végétaux de
	5 Lieu d'origine
6 Moyen de transport déclaré	
7 Point d'entrée déclaré	

8 Marques des colis; nombre et nature des colis; nom du produit; nom botanique des plantes	**9** Quantité déclarée

10 Il est certifié que les végétaux ou produits végétaux décrits ci-dessus
- ont été inspectés suivant des procédures adaptées, et
- estimés indemnes d'ennemis visés par la réglementation phytosanitaire et pratiquement indemnes d'autres ennemis dangereux, et
- sont jugés conformes à la réglementation phytosanitaire en vigueur dans le pays importateur.

11 Déclaration supplémentaire

TRAITEMENT DE DÉSINFESTATION ET/OU DE DÉSINFECTION	
12 Traitement	
13 Produit chimique (matière active)	**14** Durée et température
15 Concentration	**16** Date
17 Renseignements complémentaires	

Lieu de délivrance

Date

Nom et signature du fonctionnaire autorisé

Cachet de l'Organisation

If not, one or more of the following measures may be taken: access to EU territory may be refused, the consignment may be sent back to a destination outside the EU, the contaminated products may be removed from the consignment, destroyed, placed in quarantine pending further tests, or treated appropriately (this last measure is possible only in exceptional cases and under very precise circumstances). The Member State concerned must also inform the Commission and the other Member States of the situation and what measures have been taken.

2.2.3. Protected zones

The Directive establishes, at the request of one or more Member States, special **protected zones to guard against certain harmful organisms**.

Each zone may cover all or part of the territory of a Member State and must be defined in specific geographic terms and in relation to the harmful organisms concerned. The reason for this protection is the absence of specified harmful organisms in this zone despite conditions favourable to their development.

The additional protection provided in the protected zones includes:

- an additional list of harmful organisms the introduction and spread of which in the protected zones is prohibited;
- an additional list of plants and plant products the introduction of which into the protected zones is prohibited;
- an additional list of specific requirements to be met by certain crops and crop products when they are introduced into or moved within the EU.

2.2.4. National official bodies

The national official bodies **may delegate the tasks** attributed to them under this Directive to any legal person, whether governed by public or private law. Tasks relating to laboratory analyses may also be delegated.

However, in this specific case, the national official body shall ensure that:

- the legal person responsible for carrying out the analyses is able to **guarantee impartiality** and quality as well as the protection of confidential information;
- there are **no conflicts of interest** between the tasks entrusted to the legal person and the latter's other activities.

2.3. Harmful organisms

One of the most important measures consists in listing the particularly dangerous harmful organisms whose introduction into the Community must be prohibited and also the harmful organisms whose introduction into the Member States when carried by certain plants or plant products must also be prohibited.

2.3.1. Harmful organisms whose introduction into, and spread within, all Member States shall be banned according to Council Directive No. 2000/29/EC – Annex I, Part A

HARMFUL ORGANISMS NOT KNOWN TO OCCUR IN ANY PART OF THE COMMUNITY AND RELEVANT FOR THE ENTIRE COMMUNITY
a) Insects, mites and nematodes, at all stages of their development

- *Acleris* spp (non-European)
- *Amauromyza maculosa* (Malloch)
- *Anomala orientalis* Waterhouse
- *Anoplophora chinensis* (Thomson)
- *Anoplophora glabripennis* (Motschulsky)
- *Anoplophora malasiaca* (Forster)
- *Arrhenodes minutus* Drury
- *Bemisia tabaci* Genn (non-European populations) vector of viruses such as:
  - (a) Bean golden mosaic virus
  - (b) Cowpea mild mottle virus
  - (c) Lettuce infectious yellows virus
  - (d) Pepper mild *tigré* virus
  - (e) Squash leaf curl virus
  - (f) Euphorbia mosaic virus
  - (g) Florida tomato virus
- Cicadellidae (non-European) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), such as:
  - (a) *Carneocephala fulgida* Nottingham
  - (b) *Draeculacephala minerva* Ball
  - (c) *Graphocephala atropunctata* (Signoret)
- *Choristoneura* spp. (non-European)
- *Conotrachelus nenuphar* (Herbst)
- *Dendrolimus sibiricus* Tschetverikov
- *Diabrotica barberi* Smith and Lawrence
- *Diabrotica undecimpunctata howardi* Barber
- *Diabrotica undecimpunctata undecimpunctata* Mannerheim
- *Diabrotica virgifera zeae* Krysan & Smith
- *Heliothis zea* (Boddie)
- *Hirschmanniella* spp., other than *Hirschmanniella gracilis* (de Man) Luc and Goodey

- *Liriomyza sativae* Blanchard
- *Longidorus diadecturus* Eveleigh and Allen
- *Monochamus* spp (non-European)
- *Myndus crudus* Van Duzee
- *Nacobbus aberrans* (Thorne) Thorne and Allen
- *Naupactus leucoloma* Boheman
- *Premnotrypes* spp. (non-European)
- *Pseudopityophthorus minutissimus* (Zimmermann)
- *Pseudopityophthorus pruinosus* (Eichhoff)
- *Rhynchophorus palmarum* (L.)
- *Scaphoideus luteolus* (Van Duzee)
- *Spodoptera eridania* (Cramer)
- *Spodoptera frugiperda* (Smith)
- *Spodoptera litura* (Fabricus)
- *Thrips palmi* Karny
- Tephritidae (non-European) such as:
    (a) *Anastrepha fraterculus* (Wiedemann)
    (b) *Anastrepha ludens* (Loew)
    (c) *Anastrepha obliqua* Macquart
    (d) *Anastrepha suspensa* (Loew)
    (e) *Dacus ciliatus* Loew
    (f) *Dacus curcurbitae* Coquillet
    (g) *Dacus dorsalis* Hendel
    (h) *Dacus tryoni* (Froggatt)
    (i) *Dacus tsuneonis* Miyake
    (j) *Dacus zonatus* Saund.
    (k) *Epochra canadensis* (Loew)
    (l) *Pardalaspis cyanescens* Bezzi
    (m) *Pardalaspis quinaria* Bezzi
    (n) *Pterandrus rosa* (Karsch)
    (o) *Rhacochlaena japonica* Ito
    (p) *Rhagoletis cingulata* (Loew)
    (q) *Rhagoletis completa* Cresson
    (r) *Rhagoletis fausta* (Osten-Sacken)
    (s) *Rhagoletis indifferens* Curran
    (t) *Rhagoletis mendax* Curran
    (u) *Rhagoletis pomonella* Walsh
    (v) *Rhagoletis ribicola* Doane
    (w) *Rhagoletis suavis* (Loew)
- *Xiphinema americanum* Cobb *sensu lato* (non-European populations)
- *Xiphinema californicum* Lamberti and Bleve-Zacheo

b) Bacteria

- *Xylella fastidiosa* (Well and Raju)

c) Fungi

- *Ceratocystis fagacearum* (Bretz) Hunt
- *Chrysomyxa arctostaphyli* Dietel
- *Cronartium* spp. (non-European)
- *Endocronartium* spp. (non-European)
- *Guignardia laricina* (Saw.) Yamamoto and Ito
- *Gymnosporangium* spp. (non-European)
- *Inonotus weirii* (Murril) Kotlaba and Pouzar
- *Melampsora farlowii* (Arthur) Davis
- *Monilinia fructicola* (Winter) Honey
- *Mycosphaerella larici-leptolepis* Ito *et al*.
- *Mycosphaerella populorum* G. E. Thompson
- *Phoma andina* Turkensteen
- *Phyloosticta solitaria* Ell. and Ev.
- *Septoria lycopersici* Speg. var. *malagutii* Ciccarone and Boerema
- *Thecaphora solani* Barrus
- *Tilletia indica* Mitra
- *Trechispora brinkmannii* (Bresad.) Rogers

d) Viruses and virus-like organisms

- Elm phlöem necrosis mycoplasm
- Potato viruses and virus-like organisms such as:
  - (a) Andean potato latent virus
  - (b) Andean potato mottle virus
  - (c) Arracacha virus B, oca strain
  - (d) Potato black ringspot virus
  - (e) Potato spindle tuber viroid
  - (f) Potato virus T
  - (g) non-European isolates of potato viruses A, M, S, V, X and Y (including Y o , Y n and Y c) and Potato leafroll virus
- Tobacco ringspot virus
- Tomato ringspot virus
- Viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L.,*Rubus* L. and *Vitis* L., such as:
  - (a) Blueberry leaf mottle virus
  - (b) Cherry rasp leaf virus (American)
  - (c) Peach mosaic virus (American)
  - (d) Peach phony rickettsia
  - (e) Peach rosette mosaic virus
  - (f) Peach rosette mycoplasm
  - (g) Peach X-disease mycoplasm
  - (h) Peach yellows mycoplasm
  - (i) Plum line pattern virus (American)
  - (j) Raspberry leaf curl virus (American)
  - (k) Strawberry latent ‘C’ virus
  - (l) Strawberry vein banding virus
  - (m) Strawberry witches' broom mycoplasm
  - (n) Non-European viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L.

- Viruses transmitted by *Bemisia tabaci* Genn, such as:
  - (a) Bean golden mosaic virus
  - (b) Cowpea mild mottle virus
  - (c) Lettuce infectious yellows virus
  - (d) Pepper mild tigré virus
  - (e) Squash leaf curl virus
  - (f) Euphorbia mosaic virus
  - (g) Florida tomato virus

e) Parasitic plants

- *Arceuthobium* spp. (non-European)

HARMFUL ORGANISMS KNOWN TO OCCUR IN THE COMMUNITY AND RELEVANT FOR THE ENTIRE COMMUNITY

a) Insects, mites and nematodes, at all stages of their development

- *Diabrotica virgifera virgifera* Le Conte
- *Globodera pallida* (Stone) Behrens
- *Globodera rostochiensis* (Wollenweber) Behrens
- *Meloidogyne chitwoodi* Golden *et al*. (all populations)
- *Meloidogyne fallax* Karssen
- *Opogona sacchari* (Bojer)
- *Popilia japonica* Newman
- *Rhizoecus hibisci* Kawai and Takagi
- *Spodoptera littoralis* (Boisduval)

b) Bacteria

- *Clavibacter michiganensis* (Smith) Davis *et al*. ssp. *sepedonicus* (Spieckermann and Kotthoff) Davis *et al*.
- *Pseudomonas solanacearum* (Smith) Smith

c) Fungi

- *Melampsora medusae* Thümen
- *Synchytrium endobioticum* (Schilbersky) Percival

d) Viruses and virus-like organisms

- Apple proliferation mycoplasm
- Apricot chlorotic leafroll mycoplasm
- Pear decline mycoplasm

2.3.2. Harmful organisms whose introduction into, and whose spread within, certain protected zones shall be banned according to Council Directive No. 2000/29/EC – Annex I, Part B.

a) Insects, mites and nematodes, at all stages of their development	
Species	**Protected zone(s)**
Bemisia tabaci Genn. (European populations)	IRL, P (Azores, Beira Interior, Beira Litoral, Entre Douro e Minho, Madeira, Ribatejo e Oeste (communes of Alcobaça, Alenquer, Bombarral, Cadaval, Caldas da Rainha, Lourinhã, Nazaré, Obidos, Peniche and Torres Vedras) and Trás-os-Montes), UK, S, FI
Daktulosphaira vitifoliae (Fitch)	CY
Globodera pallida (Stone) *Behrens*	FI, LV, SI, SK
Leptinotarsa decemlineata Say	E (Ibiza and Menorca), IRL, CY, M, P (Azores and Madeira), UK, S (Malmöhus, Kristianstads, Blekinge, Kalmar, Gotlands Län, Halland), FI (the districts of Åland, Turku, Uusimaa, Kymi, Häme, Pirkanmaa, Satakunta)
Liriomyza bryoniae (Kaltenbach)	IRL and UK (Northern Ireland)
b) Viruses and virus-like organisms	
Species	**Protected zone(s)**
Beet necrotic yellow vein virus	F (Britanny), FI, IRL, P (Azores), UK (Northern Ireland)
Tomato spotted wilt virus	S, FI

2.3.3. Harmful organisms whose introduction into, and spread within, all member states shall be banned if they are present on certain plant or plant products according to Council Directive No. 2000/29/EC – Annex II, Part A

HARMFUL ORGANISMS NOT KNOWN TO OCCUR IN THE COMMUNITY AND RELEVANT FOR THE ENTIRE COMMUNITY	
a) Insects, mites and nematodes, at all stages of their development	
Species	**Subject of contamination**
Aculops fuchsiae Keifer	Plants of *Fuchsia* L., intended for planting, other than seeds
Agrilus planipennis Fairmaire	Plants intended for planting, other than plants in tissue culture and seeds, wood and bark of *Fraxinus* L., *Juglans mandshurica* Maxim., *Ulmus davidiana* Planch., *Ulmus parvifolia* Jacq. and *Pterocarya rhoifolia* Siebold & Zucc., originating in Canada, China, Japan, Mongolia, Republic of Korea, Russia, Taiwan and USA
Aleurocantus spp.	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Anthonomus bisignifer (Schenkling)	Plants of *Fragaria* L., intended for planting, other than seeds
Anthonomus signatus (Say)	Plants of *Fragaria* L., intended for planting, other than seeds
Aonidella citrina Coquillet	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Aphelenchoïdes besseyi Christie	Seeds of *Oryza* spp.
Aschistonyx eppoi Inouye	Plants of *Juniperus* L., other than fruit and seeds, originating in non-European countries
Bursaphelenchus xylophilus (Steiner and Nickle *et al*.	Plants of *Abies* Mill., *Cedrus* Trew, *Larix* Mill., *Picea* A. Dietr., *Pinus* L., *Pseudotsuga* Carr. and *Tsuga* Carr., other than fruit and seeds, and wood of

	conifers (*Coniferales*), originating in non-European countries
Carposina niponensis Walsingham	Plants of *Cydonia* Mill., *Malus* Mill., *Prunus* L. and *Pyrus* L., other than seeds, originating in non-European countries
Diaphorina citri Kuway	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, and *Murraya* König, other than fruit and seeds
Enarmonia packardi (Zeller)	Plants of *Cydonia* Mill., *Malus* Mill., *Prunus* L. and *Pyrus* L., other than seeds, originating in non-European countries
Enarmonia prunivora Walsh	Plants of *Crataegus* L., *Malus* Mill., *Photinia* Ldl., *Prunus* L. and *Rosa* L., intended for planting, other than seeds, and fruit of *Malus* Mill. and *Prunus* L., originating in non-European countries
Eotetranychus lewisi McGregor	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Grapholita inopinata Heinrich	Plants of *Cydonia* Mill., *Malus* Mill., *Prunus* L. and *Pyrus* L., other than seeds, originating in non-European countries
Hishomonus phycitis	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Leucaspis japonica Ckll.	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Listronotus bonariensis (Kuschel)	Seeds of *Cruciferae*, *Gramineae* and *Trifolium* spp., originating in Argentina, Australia, Bolivia, Chile, New Zealand and Uruguay
Margarodes, non-European species, such as: (a) *Margarodes vitis* (Phillipi) (b) *Margarodes vredendalensis* de Klerk (c) *Margarodes prieskaensis* Jakubski	Plants of *Vitis* L., other than fruit and seeds

Numonia pyrivorella (Matsumura)	Plants of *Pyrus* L., other than seeds, originating in non-European countries
Oligonychus perditus Pritchard and Baker	Plants of *Juniperus* L., other than fruit and seeds, originating in non-European countries
Pissodes spp. (non-European)	Plants of conifers (*Coniferales*), other than fruit and seeds, wood of conifers (*Coniferales*) with bark, and isolated bark of conifers (*Coniferales*), originating in non-European countries
Radopholus citrophilus Huettel Dickson and Kaplan	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds, and Plants of *Araceae*, *Marantaceae*, *Musaceae*, *Persea* spp., *Strelitziaceae*, rooted or with growing medium attached or associated
Scirtothrips aurantii Faure	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than seeds
Scirtothrips dorsalis Hood	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Scirtothrips citri (Moultex)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than seeds
Scolytidae spp. (non-European)	Plants of conifers (*Coniferales*), over 3 m in height, other than fruit and seeds, wood of conifers (*Coniferales*) with bark, and isolated bark of conifers (*Coniferales*), originating in non-European countries
Scrobipalpopsis solanivora Povolny	Tubers of *Solanum tuberosum* L.
Tachypterellus quadrigibbus Say	Plants of *Cydonia* Mill., *Malus* Mill., *Prunus* L. and *Pyrus* L., other than seeds, originating in non-European countries
Toxoptera citricida Kirk.	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds

Trioza erytreae Del Guercio	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids and *Clausena* Burm. f., other than fruit and seeds
Unaspis citri Comstock	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
b) Bacteria	
Species	**Subject of contamination**
Citrus greening bacterium	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Citrus variegated chlorosis	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Erwinia stewartii (Smith) Dye	Seeds of *Zea mais* L.
Xanthomonas campestris (all strains pathogenic to Citrus)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than seeds
Xanthomonas campestris pv. *oryzae* (Ishiyama) Dye and pv. *oryzicola* (Fang. *et al*.) Dye	Seeds of *Oryza* spp.
c) Fungi	
Species	**Subject of contamination**
Alternaria alternata (Fr.) Keissler (non-European pathogenic isolates)	Plants of *Cydonia* Mill., *Malus* Mill. and *Pyrus* L. intended for planting, other than seeds, originating in non-European countries
Anisogramma anomala (Peck) E. Müller	Plants of *Corylus* L., intended for planting, other than seeds, originating in Canada and the United States of America
Apiosporina morbosa (Schwein.) v. Arx	Plants of *Prunus* L. intended for planting, other than seeds
Apiosporina morbosa (Schwein.) v. Arx	Plants of *Pinus* L., other than fruit and seeds, isolated bark and wood of *Pinus* L.

Apiosporina morbosa (Schwein.) v. Arx	Plants of *Acer saccharum* Marsh., other than fruit and seeds, originating in the USA and Canada, wood of *Acer saccharum* Marsh., including wood which has not kept its natural round surface, originating in the USA and Canada
Cercoseptoria pini-densiflorae (Hori and Nambu) Deighton	Plants of *Pinus* L., other than fruit and seeds, and wood of *Pinus* L.
Cercospora angolensis Carv. and Mendes	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than seeds
Ciborinia camelliae Kohn	Plants of *Camelia* L., intended for planting, other than seeds, originating in non-European countries
Diaporthe vaccinii Shaer	Plants of *Vaccinium* spp., intended for planting, other than seeds
Elsinoe spp. Bitanc. and Jenk. Mendes	Plants of *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds and plants of *Citrus* L. and their hybrids, other than seeds and other than fruits, except fruits of *Citrus reticulata* Blanco and of *Citrus sinensis* (L.) Osbeck originating in South America
Fusarium oxysporum f. sp. *albedinis* (Kilian and Maire) Gordon	Plants of *Phoenix* spp., other than fruit and seeds
Guignardia citricarpa Kiely (all strains pathogenic to Citrus)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than seeds
Guignardia piricola (Nosa) Yamamoto	Plants of *Cydonia* Mill., *Malus* Mill., *Prunus* L. and *Pyrus* L., other than seeds, originating in non-European countries
Puccinia pittieriana Hennings	Plants of *Solanaceae*, other than fruit and seeds
Scirrhia acicola (Dearn.) Siggers	Plants of *Pinus* L., other than fruit and seeds
Stegophora ulmea (Schweinitz: Fries) Sydow & Sydow	Plants of *Ulmus* L. and *Zelkova* L., intended for planting, other than seeds

Venturia nashicola Tanaka and Yamamoto	Plants of *Pyrus* L., intended for planting, other than seeds, originating in non-European countries
d) Virus and virus-like organisms	
Species	**Subject of contamination**
1. Beet curly top virus (non-European isolates)	Plants of *Beta vulgaris* L., intended for planting, other than seeds
2. Black raspberry latent virus	Plants of *Rubus* L., intended for planting
3. Blight and blight-like	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
4. Cadang-Cadang viroid	Plants of *Palmae*, intended for planting, other than seeds, originating in non-European countries
5. Cherry leafroll virus	Plants of *Rubus* L., intended for planting
5.1. Chrysanthemum stem necrosis virus	Plants of *Dendranthema* (DC.) Des Moul. and *Lycopersicon lycopersicum* (L.) Karsten ex Farw., intended for planting, other than seeds
6. Citrus mosaic virus	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
7. Citrus tristeza virus (non-European isolates)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
8. Leprosis	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf. and their hybrids, other than fruit and seeds
9. Little cherry pathogen (non- European isolates)	Plants of *Prunus cerasus* L., *Prunus avium* L., *Prunus incisa* Thunb., *Prunus sargentii* Rehd., *Prunus serrula* Franch., *Prunus serrulata* Lindl., *Prunus speciosa* (Koidz.) Ingram, *Prunus subhirtella* Miq., *Prunus yedoensis* Matsum., and hybrids

	and cultivars thereof, intended for planting, other than seeds
10. Naturally spreading psorosis	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
11. Palm lethal yellowing mycoplasm	Plants of Palmae, intended for planting, other than seeds, originating in non-European countries
12. Prunus necrotic ringspot virus	Plants of *Rubus* L., intended for planting
13. Satsuma dwarf virus	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
14. Tatter leaf virus	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
15. Witches' broom (MLO)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds

HARMFUL ORGANISMS KNOWN TO OCCUR IN THE COMMUNITY AND RELEVANT FOR THE ENTIRE COMMUNITY	
a) Insects, mites and nematodes, at all stages of their development	
Species	**Subject of contamination**
Aphelenchoides besseyi Christie	Plants of *Fragaria* L., intended for planting, other than seeds
Daktulosphaira vitifoliae (Fitch)	Plants of *Vitis* L., other than fruit and seeds
Ditylenchus destructor Thorne	Flower bulbs and corms of *Crocus* L., miniature cultivars and their hybrids of the genus *Gladiolus* Tourn. ex L., such as *Gladiolus callianthus* Marais, *Gladiolus colvillei* Sweet, *Gladiolus nanus* hort., *Gladiolus ramosus* hort., *Gladiolus tubergenii* hort., *Hyacinthus* L., *Iris* L., *Trigridia* Juss, *Tulipa* L., intended for planting, and potato tubers (*Solanum tuberosum* L.), intended for planting

Ditylenchus dipsaci (Kühn) Filipjev	Seeds and bulbs of *Allium ascalonicum* L., *Allium cepa* L. and *Allium schoenoprasum* L., intended for planting and plants of *Allium porrum* L., intended for planting, bulbs and corms of *Camassia* Lindl., *Chionodoxa* Boiss., *Crocus flavus* Weston 'Golden Yellow', *Galanthus* L., *Galtonia candicans* (Baker) Decne, *Hyacinthus* L., *Ismene* Herbert, *Muscari* Miller, *Narcissus* L., *Ornithogalum* L., *Puschkinia* Adams, *Scilla* L., *Tulipa* L., intended for planting, and seeds of *Medicago sativa* L.
Circulifer haematoceps	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Circulifer tenellus	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Eutetranychus orientalis Klein	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf. Raf. and their hybrids, other than fruit and seeds
Helicoverpa armigera (Hübner)	Plants of *Dendranthema* (DC.) Des Moul, *Dianthus* L., *Pelargonium* l'Hérit. ex Ait. and of the family *Solanaceae*, intended for planting, other than seeds
Parasaissetia nigra (Nietner)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Radopholus similis (Cobb) Thorne	Plants of *Araceae*, *Marantaceae*, *Musaceae*, *Persea* spp., *Strelitziaceae*, rooted or with growing medium attached or associated
Liriomyza huidobrensis (Blanchard)	Cut flowers, leafy vegetables of *Apium graveolens* L. and plants of herbaceous species, intended for planting, other than: – bulbs, – corms, – plants of the family Gramineae, – rhizomes, – seeds

Liriomyza trifolii (Burgess)...	Cut flowers, leafy vegetables of *Apium graveolens* L. and plants of herbaceous species, intended for planting, other than: – bulbs, – corms, – plants of the family Gramineae, – rhizomes, – seeds
Paysandisia archon (Burmeister)	Plants of Palmae, intended for planting, having a diameter of the stem at the base of over 5 cm and belonging to the following genera: *Brahea* Mart., *Butia* Becc., *Chamaerops* L., *Jubaea* Kunth, *Livistona* R. Br., *Phoenix* L., *Sabal* Adans., *Syagrus* Mart., *Trachycarpus* H. Wendl., *Trithrinax* Mart., *Washingtonia* Raf.
b) Bacteria	
Species	**Subject of contamination**
Clavibacter michiganensis spp. *insidiosus* (McCulloch) Davis *et al*.	Seeds of *Medicago sativa* L.
Clavibacter michiganensis spp. *michiganensis* (Smith) Davis *et al*.	Plants of *Lycopersicon lycopersicum* (L.) Karsten ex Farw., intended for planting
Erwinia amylovora (Burr.) Winsl. *et al*.	Plants of *Amelanchier* Med., *Chaenomeles* Lindl., *Cotoneaster* Ehrh., *Crataegus* L., *Cydonia* Mill., *Eriobotrya* Lindl., *Malus* Mill., *Mespilus* L., *Photinia davidiana* (Dcne.) Cardot, *Pyracantha* Roem., *Pyrus* L. and *Sorbus* L., intended for planting, other than seeds
Erwinia chrysanthemi pv. *dianthicola* (Hellmers) Dickey	Plants of *Dianthus* L., intended for planting, other than seeds
Pseudomonas caryophylli (Burkholder) Starr and Burkholder	Plants of *Dianthus* L., intended for planting, other than seeds
Pseudomonas syringae pv. *persicae* (Prunier *et al*.) Young *et al*.	Plants of *Prunus persica* (L.) Batsch and *Prunus persica* var. *nectarina* (Ait.) Maxim, intended for planting, other than seeds

Xanthomonas campestris pv. *phaseoli* (Smith) Dye	Seeds of *Phaseolus* L.
Xanthomonas campestris pv. *pruni* (Smith) Dye	Plants of *Prunus* L., intended for planting, other than seeds
Xanthomonas campestris pv. *vesicatoria* (Doidge) Dye	Plants of *Lycopersicon lycopersicum* (L.) Karsten ex Farw. and *Capsicum* spp., intended for planting
Xanthomonas fragariae Kennedy and King	Plants of *Fragaria* L., intended for planting, other than seeds
Xylophilus ampelinus (Panagopoulos) Willems *et al*.	Plants of *Vitis* L., other than fruit and seeds
c) Fungi	
Species	**Subject of contamination**
Cryphonectria parasitica (Murrill) Barr	Plants of *Castanea* Mill and *Quercus* L., intended for planting, other than seeds
Didymella ligulicola (Baker, Dimock and Davis) v. Arx	Plants of *Dendranthema* (DC.) Des Moul., intended for planting, other than seeds
Phialophora cinerescens (Wollenweber) van Beyma	Plants of *Dianthus* L., intended for planting, other than seeds
Phoma tracheiphila (Petri) Kanchaveli and Gikashvili	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than seeds
Phytophthora fragariae Hickmann var. *fragariae*	Plants of *Fragaria* L., intended for planting, other than seeds
Plasmopara halstedii (Farlow) Berl. and de Toni	Seeds of Helianthus annuus L.
Puccinia horiana Hennings	Plants of *Dendranthema* (DC.) Des Moul., intended for planting, other than seeds
Scirrhia pini Funk and Parker	Plants of *Pinus* L., intended for planting, other than seeds
Verticillium albo-atrum Reinke and Berthold	Plants of *Humulus lupulus* L., intended for planting, other than seeds
Verticillium dahliae Klebahn	Plants of *Humulus lupulus* L., intended for planting, other than seeds

d) Viruses and virus-like organisms	
Species	**Subject of contamination**
Arabis mosaic virus	Plants of *Fragaria* L. and *Rubus* L., intended for planting, other than seeds
Beet leaf curl virus	Plants of *Beta vulgaris* L., intended for planting, other than seeds
Chrysanthemum stunt viroid	Plants of *Dendranthema* (DC.) Des Moul., intended for planting, other than seeds
Citrus tristeza virus (European isolates)	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Citrus vein enation woody gall	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Grapevine flavescence dorée MLO	Plants of *Vitis* L., other than fruit and seeds
Plum pox virus	Plants of *Prunus* L., intended for planting, other than seeds
Potato stolbur mycoplasm	Plants of *Solanaceae*, intended for planting, other than seeds
Raspberry ringspot virus	Plants of *Fragaria* L. and *Rubus* L., intended for planting, other than seeds
Spiroplasma citri Saglio *et al*.	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruit and seeds
Strawberry crinkle virus	Plants of *Fragaria* L., intended for planting, other than seeds
Strawberry latent ringspot virus	Plants of *Fragaria* L. and *Rubus* L., intended for planting, other than seeds
Strawberry mild yellow edge virus	Plants of *Fragaria* L., intended for planting, other than seeds
Tomato black ring virus	Plants of *Fragaria* L. and *Rubus* L., intended for planting, other than seeds

Tomato spotted wilt virus	Plants of *Apium graveolens* L., *Capsicum annuum* L., *Cucumis melo* L., *Dendranthema* (DC.) Des Moul., all varieties of New Guinea hybrids *Impatiens*, *Lactuca sativa* L., *Lycopersicon lycopersicum* (L.) Karsten ex Farw. *Nicotiana tabacum* L., of which there shall be evidence that they are intended for sale to professional tobacco production. *Solanum melongena* L. and *Solanum tuberosum* L., intended for planting, other than seeds
Tomato yellow leaf curl virus	Plants of *Lycopersicon lycopersicum* (L.) Karsten ex Farw., intended for planting, other than seeds

2.3.4. Harmful organisms whose introduction into, and whose spread within, certain protected zones shall be banned if they are on certain plants or plant products according to Council Directive No. 2000/29/EC – Annex II, Part B

a) Insect mites and nematodes, at all stages of their development		
Species	**Subject of contamination**	**Protected zone(s)**
Anthonomus grandis (Boh.)	Seeds and fruits (bolls) of *Gossypium* spp. and unginned cotton	EL, E (Andalusia, Catalonia, Extremadura, Murcia, Valencia)
Cephalcia lariciphila (Klug)	Plants of *Larix* Mill., intended for planting, other than seeds	IRL, UK (Northern Ireland, Isle of Man and Jersey)
Dendroctonus micans Kugelan	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr., *Pinus* L. and *Pseudotsuga* Carr., over 3 m in height, other than fruit and seeds, wood of conifers (*Coniferales*) with bark, isolated bark of conifers	EL, IRL, UK (Northern Ireland, Isle of Man and Jersey)
Gilphinia hercyniae (Hartig)	Plants of *Picea* A. Dietr., intended for planting, other than seeds	EL, IRL, UK (Northern Ireland, Isle of Man and Jersey)

Gonipterus scutellatus Gyll.	Plants of *Eucalyptus* l'Herit., other than fruit and seeds	EL, P (Azores)
(a) *Ips amitinus* Eichhof	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr. and *Pinus* L., over 3 m in height, other than fruit and seeds, wood of conifers (*Coniferales*) with bark, isolated bark of conifers	EL, F (Corsica), IRL, UK
(b) *Ips cembrae* Heer	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr. and *Pinus* L. and *Pseudotsuga* Carr., over 3 m in height, other than fruit and seeds, wood of conifers (*Coniferales*) with bark, isolated bark of conifers	EL, IRL, UK (Northern Ireland, Isle of Man)
(c) *Ips duplicatus* Sahlberg	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr. and *Pinus* L., over 3 m in height, other than fruit and seeds, wood of conifers (*Coniferales*) with bark, isolated bark of conifers	EL, IRL, UK
(d) *Ips sexdentatus* Börner	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr., *Pinus* L. over 3 m in height, other than fruit and seeds, wood of conifers (*Coniferales*) with bark, isolated bark of conifers	IRL, CY, UK (Northern Ireland, Isle of Man)
(e) *Ips typographus* Heer	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr., *Pinus* L. and *Pseudotsuga* Carr., over 3 m in height, other than fruit and seeds, wood of conifers (*Coniferales*) with bark, isolated bark of conifers	IRL, UK
Sternochetus mangiferae Fabricius	Seeds of *Mangifera* spp. originating in third countries	E (Granada and Malaga), P (Alentejo, Algarve and Madeira)

b) Bacteria		
Species	**Subject of contamination**	**Protected zone(s)**
Curtobacterium flaccumfaciens pv. *flaccumfaciens* (Hedges) Collins and Jones	Seeds of *Phaseolus vulgaris* L. and Dolichos Jacq.	EL, E, P
Erwinia amylovora (Burr.) Winsl. et al.	Parts of plants, other than fruit, seeds and plants intended for planting, but including live pollen for pollination of Amelanchier Med., Chaenomeles Lindl., Cotoneaster Ehrh., Crataegus L., Cydonia Mill., Eriobotrya Lindl., Malus Mill., Mespilus L., Photinia davidiana (Dcne.) Cardot, Pyracantha Roem., Pyrus L. and Sorbus L.	E, EE, F (Corsica), IRL, I (Abruzzo, Apúlia, Basilicata, Calabria, Campania, Emilia-Romagna (the provinces of Parma and Piacenza); Friuli-Venezia Giulia, Lazio, Liguria, Lombardy (except the province of Mantua), Marche, Molise, Piedmont, Sardinia, Sicily, Tuscany, Umbria, Valle d'Aosta, Veneto (except the provinces of Rovigo and Venice, the communes Castelbaldo, Barbona, Boara Pisani, Masi, Piacenza d'Adige, S. Urbano, Vescovana in the province of Padova and the area situated to the south of highway A4 in the province of Verona)), LV, LT, P, SI (except the regions Gorenjska, Koroška, Maribor and Notranjska), SK (except the communes of Blahová, Horné Mýto and Okoč (Dunajská Streda County), Hronovce and Hronské Kľačany (Levice County), Málinec (Poltár County), Hrhov (Rožňava County), Veľké Ripňany (Topoľčany County), Kazimír, Luhyňa, Malý Horeš, Svätuše and Zatín (Trebišov County)), FI, UK (Northern Ireland, Isle of Man and Channel Islands).

c) Fungi		
Species	**Subject of contamination**	**Protected zone(s)**
Cryphonectria parasitica (Murrill.) Barr.	Wood, excluding wood which is bark-free, and isolated bark of Castanea Mill.	IRL, S, UK (except the Isle of Man)
Glomerella gossypii Edgerton	Seeds and fruits (bolls) of *Gossypium* spp.	EL
Gremmeniella abietina (Lag.) Morelet	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr., *Pinus* L. and *Pseudotsuga* Carr., intended for planting, other than seeds	IRL, UK (Northern Ireland)
Hypoxylon mammatum (Wahl.) J. Miller	Plants of *Populus* L., intended for planting, other than seeds	IRL, UK (Northern Ireland)
d) Virus and virus-like organisms		
Species	**Subject of contamination**	**Protected zone(s)**
Citrus tristeza virus (European isolates)	Fruits of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, with leaves and peduncles	EL, F (Corsica), M, P (except Madeira)
Grapevine flavescence dorée MLO	Plants of *Vitis* L., other than fruit and seeds	CZ, FR (Champagne-Ardenne, Lorraine and Alsace), IT (Basilicata)

2.4. Quarantine pests

2.4.1. Aims of EPPO and lists A1-A2

EPPO (European and Mediterranean Plant Protection Organization) is an intergovernmental organization responsible for international cooperation in plant protection in the European and Mediterranean region. In the sense of the article IX of the FAO International Plant Protection Convention, it is the regional plant protection organization for Europe. Founded in 1951 with 15 member governments, it now has 50 member governments including nearly every country of Western and Eastern Europe and the Mediterranean region.

❑ **Aims of EPPO**

- To protect plant health in agriculture, forestry and the uncultivated environment.
- To develop an international strategy against the introduction and spread of pests (including invasive alien plants) that damage cultivated and wild plants, in natural and agricultural ecosystems.
- To encourage harmonization of phytosanitary regulations and all other areas of official plant protection action.
- To promote the use of modern, safe, and effective pest control methods.
- To provide a documentation service on plant protection.

❑ **EPPO Regional Standards**

As a result of the work being done within the different technical bodies of the Organization, EPPO makes recommendations to the National Plant Protection Organizations of its Member Governments. These recommendations are considered as Regional Standards in the sense of the IPPC.

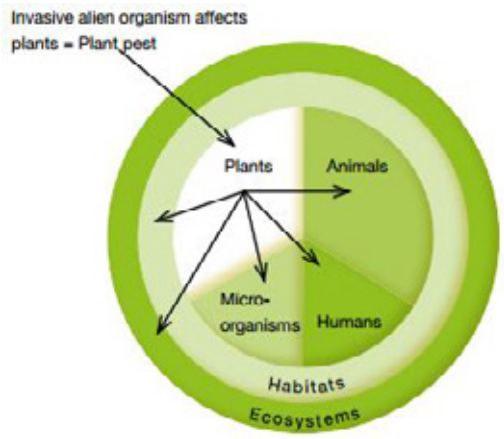
❑ **EPPO A1 & A2 Lists**

The EPPO Convention lays down that one of the aims of EPPO is "to pursue and develop, by cooperation between the Member Governments, the protection of plants and plant products against pests and the prevention of their international spread and especially their introduction into endangered areas". EPPO Council has consequently decided to draw up **lists of pests whose regulation is relevant for the whole of, or large parts of, the EPPO region**.

The EPPO A1 and A2 Lists include the pests which EPPO recommends to be **regulated as quarantine pests**, in the national phytosanitary regulations of EPPO Member Governments. These recommendations are **based on pest risk analysis** (**PRA**) and on appropriate documentation.

All consequences to be included in pest risk analysis.

The first List is of A1 pests, **not present** in the EPPO region.



Source: Identification of risks and management of invasive alien species using the IPPC framework, www.fao.org/docrep/008/y5968e/y5968e0b.htm

The second List is of A2 pests, **present in the EPPO region but not widely distributed** (i.e. absent from or not widely distributed in endangered areas in certain countries, where they are therefore subject to official control).

Definitions:

- **A1 pest** (for an area) - a quarantine pest not present in that area
- **A2 pest** (for an area) - a quarantine pest present in that area but not widely distributed there and being officially controlled
- **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
- **Regional Plant Protection Organization** - an intergovernmental organization with the functions laid down by Article VIII of the International Plant Protection Convention

2.4.2. Principles of plant quarantine as related to international trade

1. Sovereignty

With the aim of preventing the introduction of quarantine pests into their territories, it is recognized that countries may exercise the sovereign right to utilize phytosanitary measures to regulate the entry of plants and plant products and other materials capable of harbouring plant pests.

2. Necessity

Countries shall institute restrictive measures only where such measures are made necessary by phytosanitary considerations, to prevent the introduction of quarantine pests.

3. Minimal impact

Phytosanitary measures shall be consistent with the pest risk involved, and shall represent the least restrictive measures available which result in the minimum impediment to the international movement of people, commodities and conveyances.

4. Modification

As conditions change, and as new facts become available, phytosanitary measures shall be modified promptly, either by inclusion of prohibitions, restrictions or requirements necessary for their success, or by removal of those found to be unnecessary.

5. Transparency

Countries shall publish and disseminate phytosanitary prohibitions, restrictions and requirements and, on request, make available the rationale for such measures.

6. Harmonization

Phytosanitary measures shall be based, whenever possible, on international standards, guidelines and recommendations, developed within the framework of the IPPC.

7. Equivalence

Countries shall recognize as being equivalent those phytosanitary measures that are not identical but which have the same effect.

8. Dispute settlement

It is preferable that any dispute between two countries regarding phytosanitary measures be resolved at a technical bilateral level. If such a solution cannot be achieved within a reasonable period of time, further action may be undertaken by means of a multilateral settlement system.

2.4.3. Specific principles

1. Cooperation

Countries shall cooperate to prevent the spread and introduction of quarantine pests, and to promote measures for their official control.

2. Technical authority

Countries shall provide an official Plant Protection Organization.

3. Risk analysis

To determine which pests are quarantine pests and the strength of the measures to be taken against them, countries shall use pest risk analysis methods based on biological and economic evidence and, wherever possible, follow procedures developed within the framework of the IPPC.

4. Managed risk

Because some risk of the introduction of a quarantine pest always exists, countries shall agree to a policy of risk management when formulating phytosanitary measures.

5. Pest free areas

Countries shall recognize the status of areas in which a specific pest does not occur. On request, the countries in whose territories the pest free areas lie shall demonstrate this status based, where available, on procedures developed within the framework of the IPPC.

6. Emergency action

Countries may, in the face of a new and/or unexpected phytosanitary situation, take immediate emergency measures on the basis of a preliminary pest risk analysis. Such emergency measures shall be temporary in their application, and their validity will be subjected to a detailed pest risk analysis as soon as possible.

7. Notification of non-compliance

Importing countries shall promptly inform exporting countries of any non-compliance with phytosanitary prohibitions, restrictions or requirements.

8. Non-discrimination

Phytosanitary measures shall be applied without discrimination between countries of the same phytosanitary status, if such countries can demonstrate that they apply identical or equivalent phytosanitary measures in pest management. In the case of a quarantine pest within a country, measures shall be applied without discrimination between domestic and imported consignments.

2.4.4. Requirements for PEQ stations

The following may be considered by NPPOs (National Plant Protection Organization) for **PEQ** (*Post Entry Quarantine*) stations for consignments of plants.

The requirements are based on the biology of quarantine pests potentially associated with the plants. Other requirements may be necessary to address the risks from specific pests.

General requirements for PEQ stations:

- Physical separation of plants from other areas, including offices used by personnel
- Adequate safeguards to ensure plants cannot be accessed or removed from the PEQ station without appropriate authorization
- Growth of plants in pest-free growing medium (e.g. sterilized potting mix or soil-less growing medium)
- Growth of plants on raised benches
- Provision of suitable growing conditions for the imported plants (e.g. temperature, light and humidity)

- Provision of conditions conducive for the development of signs and symptoms of pests to be expressed
- Control of local pests (e.g. rodents, whiteflies, ants) and exclusion from the PEQ station by sealing all the points of penetration, including electrical and plumbing conduits (except for open ground facilities)
- A system and means for sterilization, decontamination or destruction of waste (including infested plants) and equipment (e.g. cutting implements) before removal from the station
- Appropriate irrigation system to prevent transmission of pests
- For glasshouses and screen houses: accessible surfaces constructed of smooth and impervious material for cleaning and effective decontamination
- For glasshouses and screen houses: ceilings and walls to be constructed of material resistant to deterioration and to attack by insects and other arthropods
- Protective clothing (e.g. a dedicated laboratory coat and footwear or shoe covers, disposable gloves) to be worn by all staff and visitors and removed on exit from the PEQ station
- Decontamination of personnel upon exit of PEQ station areas containing risk material

Biological characteristic (of quarantine pests)	PEQ station requirements
Pests that are exclusively graft-transmitted (e.g. some viruses or phytoplasmas, where vectors are known to be absent)	• Facilities of the station may include field site, screen house, glasshouse or laboratory • PEQ station clearly delimited • Appropriate separation from potential hosts • Host material restricted to PEQ station only
Pests spread by soil or water only, or in vectors that themselves are spread by soil or water only (e.g. cyst nematodes, nepoviruses)	• Facilities of the station may include screen house, tunnel or glasshouse • Windows and doors locked shut when not in use, and when open, windows should be fitted with screens • Footbath • Impermeable flooring • Appropriate treatment of waste and water (entering and leaving PEQ station) to eliminate quarantine pests • Appropriate treatment of soil to eliminate soil-borne vectors • Appropriate separation of plants from soil • Prevention of drainage water reaching water sources used to irrigate host plants • • Soil traps installed in drains
Pests or pest vectors that are airborne or mobile and are	• Facilities of the station may include screen house, glasshouse or laboratory • Self-closing and tight-fitting doors, with appropriate seals and sweeps

greater than 0.2 mm in size (e.g. aphids)	• Entry through two doors separated by a vestibule or anteroom • A sink with hands-free operation in the anteroom • Anteroom with insecticidal spray • Mesh less than 0.2 mm (70 mesh) (e.g. for screen houses and over vents) to prevent pest or vector entry or escape • Alternative host material for the quarantine pest should not be within the expected pest or vector dispersal distance from the PEQ station (in any direction) • Pest monitoring programme that includes the use of sticky traps, light traps or other insect monitoring devices • Inward directional air flow to be provided within the heating, ventilation and air-conditioning system • Backup electricity supply system for air flow systems and to maintain other equipment • Sterilization or decontamination of waste and equipment (e.g. cutting implements) before removal from the PEQ station
Pests or pest vectors that are airborne or mobile and less than 0.2 mm in size (e.g. some mite or thrips species)	• Facilities of the station may include glasshouse constructed of regular glass, impact-resistant polycarbonate or twin-skin plastic, or a laboratory • Self-closing and tight-fitting doors, with appropriate seals and sweeps • Entry through two doors separated by a vestibule or anteroom • A sink with hands-free operation in the anteroom • Anteroom with insecticidal spray • Alternative host material for the quarantine pest should not be within the expected pest or vector dispersal distance from the PEQ station (in any direction) • Pest monitoring programme that includes the use of sticky traps, light traps or other insect monitoring devices • Inward directional air flow to be provided within the heating, ventilation and air-conditioning system • High-efficiency particulate air (HEPA) filtration or its equivalent (HEPA filters to trap 99.97% of particles of 0.3 microns in diameter) • Sterilization or decontamination of waste and equipment (e.g. cutting implements) before removal from the PEQ station

	• A backup electricity supply system for air systems to maintain negative air pressure gradients and for other equipment • Interlocking of the supply air and exhaust air systems to ensure inward flow at all times
Pests that are highly mobile or easily dispersed (e.g. rust fungi, airborne bacteria)	• Facilities of the station may include glasshouse constructed of breakage-resistant glass or twin-walled polycarbonate, or a laboratory • Footbath • Self-closing and tight-fitting doors, with appropriate seals and sweeps • Entry through two doors separated by a vestibule or anteroom • A sink with hands-free operation in the anteroom • Alternative host material for the quarantine pest should not be within the expected pest or vector dispersal distance from the PEQ station (in any direction) • Inward directional air flow to be provided within the heating, ventilation and air-conditioning system • A backup electricity supply system for air systems to maintain negative air pressure gradients and for other equipment • No direct access to the station from the outside of the building • Interlocked vestibule doors so that only one door at a time can be opened • HEPA filtration or its equivalent (HEPA filters to trap 99.97% of particles of 0.3 microns in diameter) • All waste air filtered through HEPA filters • Sterilization or decontamination of solid and liquid waste and equipment (e.g. cutting implements) before removal from the PEQ station • Interlocking of the supply air and exhaust air systems to ensure inward flow at all times • Installation of a security alarm • A shower (may be required for staff members on leaving the station) • Monitoring systems for operational processes such as pressure differentials and wastewater treatment to prevent failure of essential systems

2.4.5. EPPO A1 List of pests recommended for regulation as quarantine pests

PROKARYOTES
Liberibacter africanum & *L. asiaticum* A1/151 *Liberibacter solanacearum* (Solanaceae haplotypes) A1/365 Palm lethal yellowing phytoplasma A1/159 Peach rosette phytoplasma A1/138 Peach yellows phytoplasma A1/139 *Phytoplasma ulmi* (Elm phloem necrosis) A1/26 Potato purple-top wilt phytoplasma A1/128 Western X-disease phytoplasma A1/140 *Xanthomonas axonopodis* pv. *allii* A1/353 *Xanthomonas axonopodis* pv. *citri* A1/1 *Xanthomonas oryzae* pv. *oryzae* A1/2 Xanthomonas oryzae pv. oryzicola A1/3 Xylella fastidiosa A1/166
FUNGI
Alternaria mali A1/277 *Anisogramma anomala* A1/201 *Apiosporina morbosa* A1/10 *Atropellis pinicola* A1/5 *Atropellis piniphila* A1/280 *Ceratocystis fagacearum* and its vectors A1/6 *Pseudopityophthorus minutissimus* *Pseudopityophthorus pruinosus* *Chrysomyxa arctostaphyli* A1/8 *Cronartium coleosporioides* A1/248 *Cronartium comandrae* A1/249 *Cronartium comptoniae* A1/250 *Cronartium fusiforme* A1/9 *Cronartium himalayense* A1/251 *Cronartium quercuum* A1/252 *Davidiella (Mycosphaerella) populorum* A1/17 *Endocronartium harknessii* A1/11 *Guignardia citricarpa* A1/194 *Gymnosporangium clavipes* A1/253 *Gymnosporangium globosum* A1/254 *Gymnosporangium juniperi-virginianae* A1/255 *Gymnosporangium yamadae* A1/257 *Melampsora farlowii* A1/15 *Mycosphaerella gibsonii* A1/7 *Mycosphaerella laricis-leptolepidis* A1/16 *Ophiognomonia (=Sirococcus) clavigignenti-juglandacearum* A1/329 *Ophiostoma wageneri* A1/179 *Phaeoramularia angolensis* A1/298 Phellinus weirii A1/19 Phoma andigena A1/141 Phyllosticta solitaria A1/20 *Phymatotrichopsis omnivora* A1/21

Puccinia hemerocallidis A1/346
Puccinia pittieriana A1/155
Septoria lycopersici var. *malagutii* A1/142
Stegophora ulmea A1/315
Thecaphora solani A1/4
Tilletia indica A1/23

PARASITIC PLANTS

Arceuthobium spp. (non-European) A1/24

- *Arceuthobium abietinum*
- *Arceuthobium americanum*
- *Arceuthobium campylopodum*
- *Arceuthobium douglasii*
- *Arceuthobium laricis*
- *Arceuthobium minutissimum*
- *Arceuthobium occidentale*
- *Arceuthobium pusillum*
- Arceuthobium tsugense
- Arceuthobium vaginatum

VIRUSES

Merican plum line pattern virus (Ilarvirus) A1/28
Andean potato mottle virus (Comovirus) A1/245
Bean golden mosaic virus (Begomovirus) A1/204
Cherry rasp leaf virus (Cheravirus) A1/127
Chrysanthemum stem necrosis virus *(Tospovirus)* A1/313
Citrus blight disease A1/278
Citrus leprosis virus A1/284
Citrus mosaic virus (Badnavirus) A1/285
Citrus tatter leaf virus *(Capillovirus)* A1/191
Coconut cadang-cadang viroid (Cocadviroid) A1/192
Eggplant mosaic virus (Andean potato latent virus) (Tymovirus) A1/244
Lettuce infectious yellows virus (Crinivirus) A1/212
Peach mosaic virus (Trichovirus) A1/27
Peach rosette mosaic virus (Nepovirus) A1/219
Potato black ringspot virus (Nepovirus) A1/246
Potato virus T A1/247
Potato yellow dwarf virus (Nucleorhabdovirus) A1/29
Potato yellow vein virus (*Crinivirus*) A1/30
Potato yellowing virus A1/220
Raspberry leaf curl virus *(Nepovirus)* A1/31
Strawberry latent C virus A1/129
Tomato mottle virus (Begomovirus - and other American Geminiviridae of capsicum and A1/225
Watermelon silver mottle virus (Tospovirus) A1/294

NEMATODES
Nacobbus aberrans A1/144 *Radopholus similis* (attacking citrus, formerly *R. citrophilus*) A1/161 *Xiphinema americanum sensu stricto* A1/150 *Xiphinema bricolense* A1/260 *Xiphinema californicum* A1/261
INSECTS AND MITES
Acleris gloverana A1/281 *Acleris variana* A1/32 *Agrilus anxius* A1/362 *Aleurocanthus woglumi* A1/103 *Anastrepha fraterculus* A1/229 *Anastrepha ludens* A1/230 *Anastrepha obliqua* A1/231 *Anastrepha suspensa* A1/200 *Anoplophora glabripennis* A1/296 *Anthonomus bisignifer* A1/189 *Anthonomus eugenii* A1/202 *Anthonomus grandis* A1/34 *Anthonomus signatus* A1/164 *Bactericera cockerelli* A1/366 *Bactrocera cucumis* A1/203 *Bactrocera cucurbitae* A1/232 *Bactrocera dorsalis* A1/233 *Bactrocera invadens* A1/357 *Bactrocera minax* A1/234 *Bactrocera tryoni* A1/235 *Bactrocera tsuneonis* A1/236 *Bactrocera zonata* A1/302 *Blitopertha orientalis* A1/33 *Ceratitis rosa* A1/237 *Choristoneura conflictana* A1/205 *Choristoneura fumiferana* A1/206 *Choristoneura occidentalis* A1/207 *Choristoneura rosaceana* A1/208 *Conotrachelus nenuphar* A1/35 *Cydia packardi* A1/209 *Cydia prunivora* A1/36 *Dendroctonus adjunctus* A1/43 *Dendroctonus brevicomis* A1/263 *Dendroctonus frontalis* A1/264 *Dendroctonus ponderosae* A1/265 *Dendroctonus pseudotsugae* A1/266 *Dendroctonus rufipennis* A1/267 *Diabrotica barberi* A1/210 *Diabrotica speciosa* A1/303 *Diabrotica undecimpunctata* A1/292 *Diaphorina citri* A1/37 *Dryocoetes confusus* A1/268 *Epitrix subcrinita* A1/358

Epitrix tuberis A1/165
Gnathotrichus sulcatus A1/269
Gonipterus gibberus A1/301
Helicoverpa zea A1/195
Heteronychus arator A1/297
Homalodisca coagulata A1/336
Ips calligraphus A1/270
Ips confusus A1/271
Ips grandicollis A1/272
Ips lecontei A1/273
Ips pini A1/274
Ips plastographus A1/275
Keiferia lycopersicella A1/367
Leucinodes orbonalis A1/368
Listronotus bonariensis A1/168
Malacosoma americanum A1/276
Malacosoma disstria A1/213
Margarodes prieskaensis A1/214
Margarodes vitis A1/215
Margarodes vredendalensis A1/216
Melanotus communis A1/305
Metamasius hemipterus A1/356
Naupactus leucoloma A1/293
Nemorimyza (Amauromyza) maculosa A1/152
Oligonychus perditus A1/217
Orgyia pseudotsugata A1/218
Pheletes (Limonius) californicus A1/304
Pissodes nemorensis A1/44
Pissodes strobi A1/258
Pissodes terminalis A1/259
Premnotrypes latithorax, *P. suturicallus* & *P. vorax* A1/143
Rhagoletis fausta A1/241
Rhagoletis indifferens A1/242
Rhagoletis mendax A1/243
Rhagoletis pomonella A1/41
Rhizoecus hibisci A1/300
Rhynchophorus palmarum A1/332
Saperda candida A1/ 359
Scirtothrips aurantii A1/221
Scirtothrips citri A1/222
Spodoptera eridania A1/196
Spodoptera frugiperda A1/197
Spodoptera litura A1/42
Sternochetus mangiferae A1/286
Thrips palmi A1/175
Unaspis citri A1/226

2.4.6. EPPO A1 List of pests recommended for regulation as quarantine pests

PROKARYOTES
Burkholderia caryophylli A2/55 *Clavibacter michiganensis* subsp. *insidiosus* A2/49 *Clavibacter michiganensis* subsp. *michiganensis* A2/50 *Clavibacter michiganensis* subsp. *sepedonicus* A2/51 *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* A2/48 *Dickeya dianthicola (Erwinia chrysanthemi* pv. *dianthicola)* A2/53 *Erwinia amylovora* A2/52 *Pantoea stewartii* A2/54 *Phytoplasma mali* (Apple proliferation) A2/87 *Phytoplasma pyri* (Pear decline) A2/95 *Phytoplasma solani* (Stolbur) A2/100 *Phytoplasma vitis* (Grapevine flavescence dorée) A2/94 *Pseudomonas syringae* pv. *actinidiae* A2/370 *Pseudomonas syringae* pv. *persicae* A2/145 *Ralstonia solanacearum* A2/58 *Xanthomonas arboricola* pv. *corylina* A2/134 *Xanthomonas arboricola* pv. *pruni* A2/62 *Xanthomonas axonopodis* pv. *dieffenbachiae* A2/180 *Xanthomonas axonopodis* pv. *phaseoli* A2/60 *Xanthomonas axonopodis* pv. *poinsettiicola* A2/350 *Xanthomonas axonopodis* pv. *vesicatoria* and *Xanthomonas vesicatoria* A2/157 *Xanthomonas fragariae* A2/135 *Xanthomonas translucens* pv. *translucens* A2/183 *Xylophilus ampelinus* A2/133
FUNGI
Botryosphaeria laricina A2/12 *Ceratocystis fimbriata* f.sp. *platani* A2/136 *Ciborinia camelliae* A2/190 *Cronartium kamtschaticum* A2/18 *Cryphonectria parasitica* A2/69 *Diaporthe vaccinii* A2/211 *Didymella ligulicola* A2/66 *Fusarium foetens* A2/345 *Fusarium oxysporum* f.sp. *albedinis* A2/70 *Gibberella circinata* A2/306 *Glomerella gossypii* A2/71 *Gymnosporangium asiaticum* A2/13 *Melampsora medusae* A2/74 *Monilinia fructicola* A2/153 *Mycosphaerella dearnessii* A2/22 *Phialophora cinerescens* A2/77 *Phoma tracheiphila* A2/287 *Phytophthora fragariae* A2/79 *Phytophthora lateralis* A2/337 *Puccinia horiana* A2/80

Stenocarpella macrospora A2/67
Stenocarpella maydis A2/68
Synchytrium endobioticum A2/82
Verticillium albo-atrum & *V. dahliae* (hop-infecting strains) A2/85

VIRUSES

Beet leaf curl virus A2/90
Beet necrotic yellow vein virus (Benyvirus) A2/160
Blueberry leaf mottle virus (Nepovirus) A2/198
Blueberry scorch virus (Carlavirus) A2/347
Chrysanthemum stunt viroid (Pospiviroid) A2/92
Citrus tristeza virus (Closterovirus) A2/93
Cucumber vein yellowing virus (Ipomovirus) A2/316
Cucurbit yellow stunting disorder virus (Crinivirus) A2/324
Impatiens necrotic spot virus (Tospovirus) A2/291
Pepino mosaic virus A2/369
Plum pox virus (Potyvirus) A2/96
Potato spindle tuber viroid (Pospiviroid) A2/97
Raspberry ringspot virus (Nepovirus) A2/98
Satsuma dwarf virus (Sadwavirus) A2/279
Squash leaf curl virus (Begomovirus) A2/224
Strawberry veinbanding virus (Caulimovirus) A2/101
Tobacco ringspot virus (Nepovirus) A2/228
Tomato chlorosis virus (Crinivirus) A2/323
Tomato infectious chlorosis virus (Crinivirus) A2/348
Tomato ringspot virus (Nepovirus) A2/102
Tomato spotted wilt virus (Tospovirus) A2/290
Tomato yellow leaf curl virus (Begomovirus) and related viruses A2/182

INSECTS AND MITES

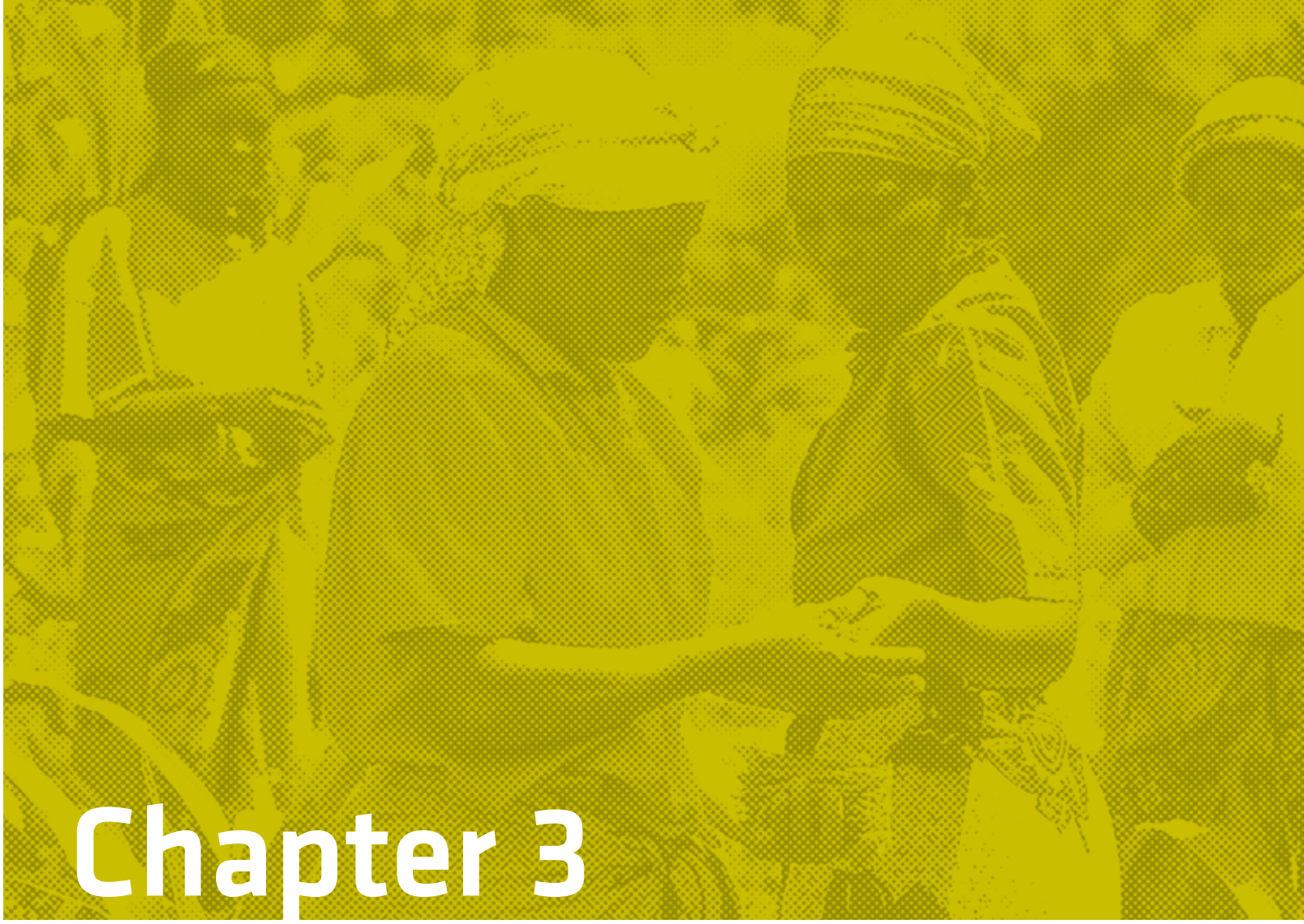
Aculops fuchsiae A2/185
Aeolesthes sarta A2/307
Agrilus planipennis A2/322
Aleurocanthus spiniferus A2/186
Anoplophora chinensis A2/187
Bemisia tabaci A2/178
Cacoecimorpha pronubana A2/104
Cacyreus marshalli A2/181
Carposina sasakii A2/163
Ceratitis capitata A2/105
Cydia inopinata A2/193
Dacus ciliatus A2/238
Dendrolimus sibiricus A2/308
Dendrolimus superans A2/330
Diabrotica virgifera A2/199
Drosophila suzukii A2/363
Dryocosmus kuriphilus A2/317
Epitrix cucumeris A2/299
Epitrix similaris A2/360
Erschoviella musculana A2/318
Eutetranychus orientalis A2/288

Frankliniella occidentalis A2/177
Gonipterus scutellatus A2/38
Helicoverpa armigera A2/110
Hesperophanes campestris A2/343
Ips hauseri A2/326
Ips subelongatus A2/325
Lepidosaphes ussuriensis A2/319
Leptinotarsa decemlineata A2/113
Liriomyza huidobrensis A2/283
Liriomyza sativae A2/282
Liriomyza trifolii A2/131
Lopholeucaspis japonica A2/289
Lymantria mathura A2/331
Maconellicoccus hirsutus A2/314
Malacosoma parallela A2/320
Megaplatypus mutatus A2/344
Numonia pirivorella A2/184
Opogona sacchari A2/154
Paysandisia archon A2/338
Popillia japonica A2/40
Quadraspidiotus perniciosus A2/117
Rhagoletis cingulata A2/239
Rhynchophorus ferrugineus A2/339
Scirtothrips dorsalis A2/223
Scolytus morawitzi A2/309
Sirex ermak A2/327
Spodoptera littoralis A2/120
Strobilomya viaria A2/333
Tecia solanivora A2/310
Tetranychus evansi A2/349
Tetropium gracilicorne A2/311
Toxoptera citricida A2/45
Trioza erytreae A2/46
Trogoderma granarium A2/121
Tuta absoluta A2/321
Viteus vitifoliae A2/106
Xylotrechus altaicus A2/312
Xylotrechus namanganensis A2/328

NEMATODES

Aphelenchoides besseyi A2/122
Bursaphelenchus xylophilus 1 A2/158
Ditylenchus dipsaci A2/174
Globodera pallida A2/124
Globodera rostochiensis A2/125
Heterodera glycines A2/167
Meloidogyne chitwoodii A2/227
Meloidogyne enterolobii A2/361
Meloidogyne fallax A2/295
Radopholus similis (not attacking citrus) A2/126
Xiphinema rivesi A2/262

INVASIVE PLANTS
Crassula helmsii A2/340 *Eichhornia crassipes* A2/351 *Heracleum persicum* A2/354 *Heracleum sosnowskyi* A2/355 *Hydrocotyle ranunculoides* A2/334 *Ludwigia peploides & L.grandiflora* A2/364 *Polygonum perfoliatum* A2/352 *Pueraria lobata* A2/341 *Solanum elaeagnifolium* A2/342



Chapter 3

The general principles of pest risk assessment

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ISPM Standard No. 2: Guidelines for pest risk analysis 79

3.1. Introduction to pest risk assessment

3.1.1. Pest Risk Assessment in the context of risk analysis

It is important to make a clear distinction between the two concepts: Pest Risk Assessment and Pest Risk Analysis.

- **Pest Risk Analysis** which can be abbreviated to the initials, PRA (ISPM No. 5, 2011) is *"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"* (FAO, 1995; ISPM No. 2, 2007).
- **Pest Risk Assessment** (sometimes informally abbreviated to PRA) is the *"Evaluation of the probability of the introduction and spread of a pest and the magnitude of the associated potential economic consequences"* (FAO, 1995; ISPM No. 11, 2004; ISPM No. 2, 2007).
- It should be noted that this definition of Pest Risk Assessment **applies to quarantine pests**. A quarantine pest is *"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, 1995; IPPC 1997).

A pest can be of any taxa and we use the definition of a pest as 'any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (IPPC, 1997). The **EPPO A1 and A2 Lists** (EPPO, 2011) include the pests which EPPO recommends to be regulated as quarantine pests, in the national phytosanitary regulations of EPPO Member Governments. These recommendations are based on pest risk analysis with appropriate documentation. Pest Risk Assessments have therefore already been carried out on these organisms and judged them to pose significant risk to EU member states.

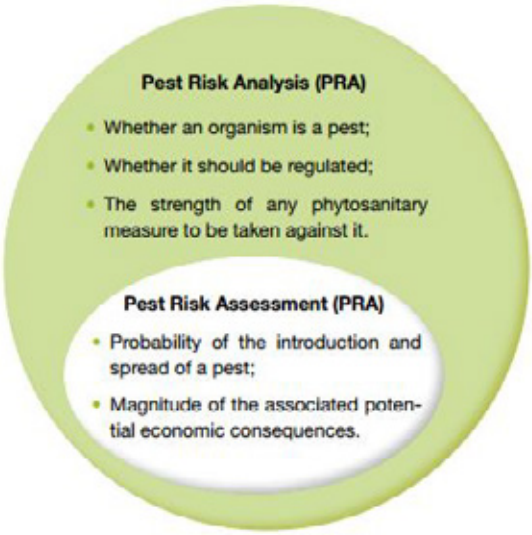
Throughout this handbook, the abbreviation **'PRA' is used only to refer to Pest Risk Analysis**. No abbreviation for Pest Risk Assessment is given in the international standards, so the term Pest Risk Assessment is used in full.

Pest Risk Assessment is a component of Pest Risk Analysis; it is concerned purely with the process of assessment of risk whilst the identification and evaluation of risk reduction options together with decisions based on the assessment fall under the wider scope of Pest Risk Analysis (Figure 1).

The purpose of Pest Risk Assessment is to estimate the likelihood of successful invasion by plant pests, and the magnitude of the consequences should such an invasion occur. Pest Risk Assessment is considered under four broad headings relating to the potential Entry, Establishment, Spread and Consequences/Impact of the pest. These will be elaborated in detail later.

In the context of PRA many apparently familiar terms have a specific definition and a glossary is provided in Annex 2.

Figure 1: The relationship between Pest Risk Analysis and Pest Risk Assessment



3.1.2. When to carry out a pest risk assessment – How is it initiated?

A Pest Risk Analysis is usually initiated either because a new commodity trade route or some other pathway could engender a new pest risk or because a pest has been identified posing a potential threat. Sometimes a PRA may be initiated due to changes in policy which mean that the criteria for assessment change in some way (EPPO 2011).

A PRA initiated by the identification of a pathway could occur because:

- international trade is initiated in a commodity not previously imported into the country;
- a commodity comes 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, garbage, passenger baggage, etc.);
- a Systems Approach or other management change is proposed for an international trade.

Where initiation is due to the identification of a new pathway a list of pests likely to be associated with the pathway should be drawn up and preferably prioritized, based on pest distribution, pest status and expert judgment. Any such prioritization is naturally preliminary because it in a sense pre-judges the outcome of the assessment, but may indicate the relative urgency to complete PRAs for each of the pests identified.

A PRA initiated by the identification of a pest could occur because:

- 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;
- a previous PRA is being re-evaluated;
- an organism has been identified as a vector for other pests;
- the pest potential of an organism in the PRA area needs to be evaluated even though the organism may not be known to be a pest.

A PRA initiated by the review or revision of a policy could occur because:

- 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 (EPPO, FAO) is assessed;
- a dispute arises about what phytosanitary measures are necessary.

In all cases therefore a PRA concerns a particular pest but where a PRA is initiated by a pathway or a policy it may be necessary to carry out a series of PRAs, for each pest concerned. The initiation stage of the PRA requires a clear statement of the scope of the PRA area; this is important because many of the later questions can only be answered in the context of a specific area. The PRA area can be a complete country, several countries or part(s) of one or several countries. These areas do not need to be contiguous.

At this stage is also important to establish whether any earlier analysis has been carried out for the pest or for very similar pests. The information in an earlier analysis may be sufficient so that a new PRA is not needed or at least it would provide some of the information required in a new PRA.

Before starting the Pest Risk Assessment stage, it is also useful to gather information about:

- the host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants) and to indicate the ones which are present in the PRA area;
- the pest distribution.

3.1.3. Types of information required to carry out a pest risk assessment

There are a number of documented approaches for the carrying out of a pest risk assessment. In this notebook we focus on that of the European and Mediterranean Plant Protection Organization (EPPO). Irrespective of the assessment protocol used, however, the same factors have to be considered. They can be grouped under the following topics:

- the organism – taxonomy, identification and detection;
- biological characteristics of the pest – development, life cycle, reproduction, dispersal, survival capability and adaptability;
- geographical distribution of the pest;
- host plants of the pest – in current area and PRA area;
- potential of the pest for establishment in PRA area – climate / eco-climatic zone;
- control of the pest – measured used, previous eradication attempts;
- transport of the pest – main trade routes of commodities with which the pest is associated, other records of movement, interception records;
- economic, environmental and social impact – extent, magnitude, prevention and mitigation potential.

A detailed breakdown of the information required is provided in Annex 3. The information can be summarized in the form of a Pest Data Sheet and an example of such a sheet for *Xanthomonas axonopodis* pv. *alii*, the causal agent of onion leaf blight, is provided in Annex 4.

3.2. Concepts of risk and risk analysis

The concept of risk has two dimensions or parts: **probability and consequences**.

It is the probability of an adverse event and the magnitude of the consequences, should the event occur. Pest risk (for quarantine pests) is defined as *'the probability of introduction and spread of a pest and the magnitude of the associated potential economic consequences'* (ISPM No. 2, 2007). The adverse event is therefore the introduction and spread of the pest and we must assess both the likelihood that this will occur and the potential consequences if it does. Likelihood and consequences have different units. One is linked to the probability of an event and the other may be a measure of harm, economic, environmental, social or public health, in monetary or other appropriate units. In assessing risk it is therefore helpful to consider as far a possible these two dimensions separately, and finally arrive at an overall assessment by integrating the two. There is however unavoidable overlap between the likelihood and consequence dimensions of risk, particularly in relation to spread. A likelihood of spread can be described but the extent of spread also affects the magnitude of the consequences.

How likely it is that something will happen and magnitude of the impact if it does, are both uncertain. Risk assessment therefore requires some way of measuring and expressing this uncertainty.

In general terms risk analysis concerns the gathering, evaluating, and recording of information which can lead to recommendations for action in response to an identified hazard. In order to manage the risk it must first be assessed or measured. The following sequence is a common way to summarize the risk assessment process: Initiation (including identification of the hazard), Risk Assessment (evaluating probability, consequences and uncertainty), Risk Management (choices between measures, their efficacy, feasibility, impacts) and Risk Communication.

❑ **Initiation**

What is the adverse event (hazard), *i.e*. a potential pest or pathway?

❑ **Risk assessment**

- What information is available?
- What is the quantity and quality of information?
- What is the probability that the event will take place?
- What is the magnitude of the potential consequences in the absence of risk reduction options?
- Is it necessary to implement any risk reduction options?

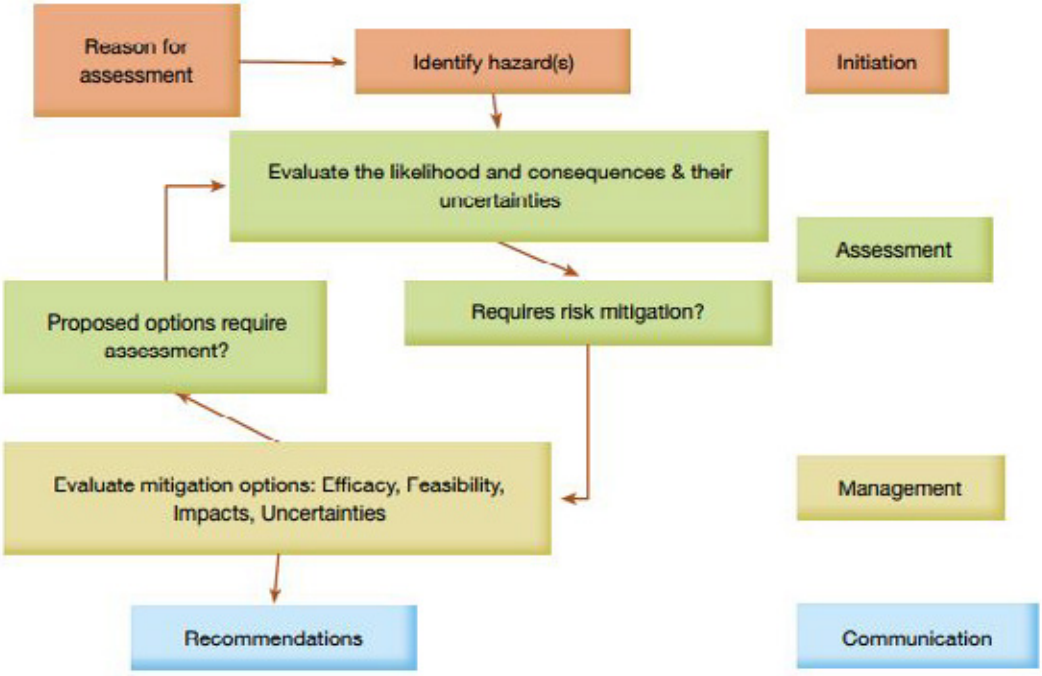
❑ **Risk management**

- Identify what can be done to eliminate or reduce the hazard, either its probability or consequences or both?
- Evaluate the potential options: How effective? How feasible? What impacts do they have?
- Identify uncertainties associated with efficacy, feasibility and impact of each option;
- Give a prioritization of options or combinations of options.

❑ **Risk communication**

- Exchanges of information and opinions to facilitate better understanding and decisions: Dissemination, Consultation, Justification;
- Document information sources, processes and methods;
- Provide rationale for conclusions and decisions;
- Describe uncertainty and identify knowledge gaps.

Figure 2: General scheme for a risk analysis process



3.2.1. The precautionary principle

Pest Risk Assessment is a process of making judgements under conditions of uncertainty and more generally, Pest Risk Analysis a process of making decisions given this uncertainty. Uncertainty is ubiquitous in PRA but of course more information is available to inform judgement in some cases than in others. A distinction can be made between inherent variability and uncertainty. Variability is not reduced with more or better information, so for example we may have very precise information about the probability of survival of a pest organism during the transportation of a commodity but it is stochastic variation which determines the survival of specific pest individuals in specific lots of the commodity. Uncertainty on the other hand may be due to errors in monitoring/surveillance, errors in the assumptions or risk analysis process, missing or incomplete information.

Principle 15 of the Rio Declaration on Environment and Development (1992) states that '*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*' This principle would support erring on the safe side in the face of uncertainties when assessing the likelihood and consequences of an invasive pest. A key purpose of the risk assessment process is to identify the uncertainties and establish the extent to which scientific evidence is available to inform judgement. Precaution has a role in arriving at an assessment of risk taking into account the scientific evidence and the uncertainty. It should be stressed that measures adopted by countries to protect their territories from pest introductions should be technically justified. Since zero-risk is not a reasonable expectation, the guiding principle for risk management should be to manage risk to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources. The measures should be as precise as possible as to consignment type (hosts, parts of plants) and origin so as not to act as barriers to trade by limiting the import of products where this is not justified (ISPM 11, 2004).

3.2.2. Descriptions of risk and uncertainty in PRA

Pest Risk Analysis decision support schemes (DSS for PRA), such as the EPPO (EPPO 2009; 2011), EFSA (EFSA 2010) and GB NNRAP's schemes (Baker *et al.*, 2008; Mumford *et al.*, 2010) (the latter two being based on the EPPO DSS for PRA) generate many ratings for factors determining likelihood and impact / consequences each with their own associated scores for uncertainty or confidence. In accordance with ISPM 11, large numbers of questions have been devised to assess the factors determining pest risk and these are grouped under four main sections in the pest risk assessment: entry, establishment, spread and impact.

These schemes are based around the use of discrete, qualitative or ordinal responses to the questions which form the components of the risk assessment. Several scales have been employed, e.g. (very low, low, medium, high, very high), (very unlikely, likely, moderately likely, likely, very likely) or (minimal, minor, moderate, major, massive).

With some exceptions, 5-point scales are used and risk increases from left to right in the sequences, so a score of '1' always corresponds to the lowest risk and '5' to the highest. The question ratings have quantitative, semi-quantitative or qualitative definitions to aid assessors in their selection.

Associated with the rating, there is a score for uncertainty which is frequently expressed on a 3-point or 4-point, qualitative scale (e.g. low, medium, high). Uncertainty refers to the degree of confidence that an assessor has that the rating he/she has selected is the correct one. Adapted from Intergovernmental Panel for Climate Change definitions (IPCC 2005), low, medium and high uncertainty were defined as expressing 90, 50 and 35% confidence, respectively, that the rating selected is the correct one (Holt *et al.*, 2012).

Risk is described in terms of likelihood and impact / consequence so ratings of risk components are of two basic kinds, with some variations in wording appropriate to the context of different questions. Where estimation in quantitative terms is possible, ratings which represent an estimation of likelihood (or proportion) can be defined as rating categories corresponding to a probability (proportion) interval and should also incorporate a pre-declared time scale, e.g. the probability that the pest will establish in the next 5 years, or the proportion of the endangered area into which the pest will spread in the next 5 years, etc. A useful scale is provided by the IPCC (IPCC, 2005) (Table1).

Table 1: Probability ranges corresponding to linguistic descriptions of the rating categories (after IPCC, 2005)

Qualitative description	Probability of occurrence in a specified period
Very Unlikely	0 – 0.10
Unlikely	0.10 – 0.33
Moderately Likely	0.33 – 0.67
Likely	0.67 – 0.90
Very Likely	0.90 - 1

Proportions, for example relating to the spread may employ the same intervals.

Where impact or consequences can be defined in terms of monetary impact, intervals (€/year) using order-of-magnitude (log 10) categories may be useful (e.g. AS/NZS (2004) Risk Management Standard) and refers to user-defined Potential Loss or Potential Control Cost. For example, if the Potential Loss is estimated at €10 billion/year then this value is taken to be the upper limit of the highest category (massive); the limits of the other categories follow from the order-of-magnitude (Table 2).

Table 2: Example of impact scale using order-of-magnitude steps where the example Loss Potential has been set to €10 billion per year

Qualitative description	Probability of occurrence in X years
Massive	€1 billion - €10 billion pa
Major	€100 million - €1 billion pa
Moderate	€10 million - €100 million pa
Minor	€1 million - €10 million pa
Minimal	€100,000 - €1 million pa

The IPCC guidelines (IPCC, 2005) offer an approach to expressing uncertainty which has been applied to PRA (Holt *et al.*, 2012; CAPRA, 2012) (Table 3).

Table 3: The uncertainty classification based on IPCC guidelines (IPCC, 2005) and modified for the EPPO DSS for PRA (CAPRA, 2012)

Confidence ratings from IPCC 2005	% chance of the chosen score being correct	Uncertainty ratings in EPPO scheme
Low	20% (35%*)	High
Medium	50%	Medium
High	80%	Not used
Very High	90%	Low

* *A 20% chance of being correct from IPCC guidelines was amended to 35% for the EPPO scheme (CAPRA, 2012) because a 20% chance of being correct in a five category system equates to a uniform distribution in which no score is more likely than any other.*

The IPCC definitions (Table 3) refer only to the probability that the selected rating is correct but say nothing about the probabilities associated with the other ratings being correct. These probabilities would of course be lower, there being some distribution where the selected rating represents the most likely (mode). Uncertainty can therefore be expressed as a distribution of ratings: for example, if uncertainty is low, 90% of the rating distribution would (by definition) lie in the selected rating and the remaining 10% would fall in other, probably adjacent, ratings. The exact shape of the distribution requires further assumptions which are discussed in Holt *et al.* (2012).

3.3. Pest risk assessment sequences

3.3.1. Pest categorization

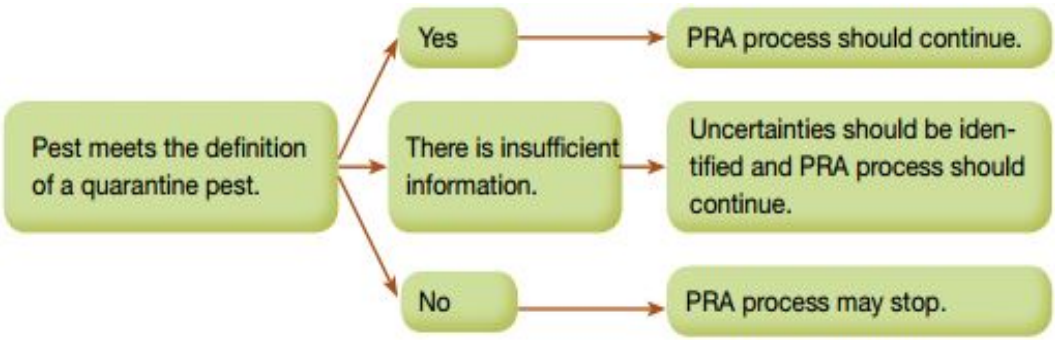
The first in a sequence of activities that constitute Pest Risk Assessment is termed 'pest categorization'. It is the process for 'determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest' (ISPM No. 11, 2004). Before committing resources to a full PRA therefore, pest categorization can determine whether the assessment should continue. The process contains the same basic elements but is less detailed than a full assessment and therefore requires relatively little information. The question that should be answered during pest categorization is whether the pest meets the criteria for a quarantine pest, *i.e.* "*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*" (ISPM No. 5, 2011).

The elements are:

- Identification of the pest (or potential pest) – an unambiguous description of the pest's taxonomy;
- Determination of whether the organism is a pest – does it have attributes that would make it a pest;
- Presence or absence in the PRA area and regulatory status (pest status) – is it in the PRA area already and to what extent;
- Potential for establishment and spread in the PRA area – presence of hosts, suitable climate and, if appropriate, any necessary vector;
- Potential for economic consequences in PRA area – given hosts and climate and the organism's attributes are there indications that the pest is likely to have an unacceptable economic impact in the PRA area.

Having addressed the above elements a decision is made about whether the pest meets the criterion to define it as a quarantine pest. Sometimes there is too little known about the pest to make a decision, in which case the PRA is recommended to continue (Figure 3).

Figure 3: Outcome of pest categorization



3.3.2. Entry potential

Pest entry is defined as the "*Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled*" (FAO, 1995). However a PRA is initiated, the concept of the pathway always forms the basis upon which entry potential is considered. If the PRA was pathway-initiated the nature of the pathway will be specified in more detail during the assessment of entry potential. If the PRA was pest-initiated, then the relevant pathways must also be specified first. There is often more than one pathway to consider which will allow the entry of a pest. Where the pathway is via some commodity the evaluation involves the consideration of the source, intended use, timing and volume.

Some most common pathways are:

- Those associated with direct association with a traded commodity, i.e. where the commodity is a host for the pest, e.g. a host plant of the pest, a part of the host plant, seeds fruits, etc., which may harbour the pest, soil associated with the imported host plant;
- Those associated with transport itself, e.g. packaging associated with trade. That which is traded may have no relevance to the pest at all but the pest may have an opportunity for association with the packaging, e.g. wood packing crates, accidental entry to shipping containers, vehicles or airplanes;
- Natural pathways whereby the pest moves into the PRA area by dispersing actively or passively by wind, water or over land.

Although in most cases there may be little opportunity to carry out risk reduction options affecting natural spread, it is important to consider this pathway (when relevant) as a high likelihood of natural spread may mean that phytosanitary measures directed at other pathways, whilst effective for those pathways, do little to prevent the overall likelihood of entry.

It is common practice when performing PRAs to group pathways of similar commodities (e.g. seeds of host plants) except if there is a very good reason to do otherwise (e.g. clear difference in host status of different genus or species, i.e. minor or major hosts). When referring to pathways very specifically however they are usually described in the following way: *Commodity* from *Area X* to *Area Y* (between *Month U* and *Month V*) for *Use Z*, e.g. Mangos from Pakistan to UK between May and August for consumption as fresh fruit. The source, destination and use are usually specified and if relevant, the season of the year.

Assessment of Entry Potential Proceeds as follows. First, selection should be made of the relevant pathways starting with those which appear most important. If these pathways involve different origins and end uses, it is usually considered sufficient to consider only the realistic worst-case pathways. The following factors are then considered for each relevant pathway in turn, starting with the most important.

Association of the pest with the pathway dependent on:

- whether it is at a life stage that would be associated with commodities, containers, or conveyances;
- whether the season is relevant for association to occur;
- the concentration of the pest on the pathway given measures used including pre-shipment phytosanitary measures already in place in the country of origin.

Volume of movement (per unit time) dependent on:

- quantities of the traded commodity, packing materials, persons, baggage, mail and conveyances;
- for natural spread, movement of the pest should be estimated.

Survival during transport dependent on:

- speed and conditions of transport (including treatments performed during transport);
- vulnerability to the conditions of the life-stages likely to be transported (for plants viability of seeds or other propagules, for all pests tolerance of low or elevated temperatures);
- whether the life cycle is of sufficient duration to extend beyond time in transit.

Detection before entry which may be influenced by:

- ease of detection and visibility of the transported life stage;
- symptom expression (disease may be latent);
- distinctiveness / distinguishability of symptoms;
- accessibility of the consignment for inspection;
- inspection protocol, e.g. consignment sampling method (existing inspection measures may change so it is necessary to bear in mind that the likelihood of detection is not necessarily fixed).

Transfer to a suitable host or habitat dependent on:

- innate dispersal mechanisms or the need for vectors;
- the extent of suitable hosts or habitats in the PRA area;
- the extent of the distribution chain of the commodity throughout the PRA area;
- the suitability of the arrival season for the pest;
- the intended use of the commodity, e.g. processing, consumption, planting, disposal of waste, by-products. Some uses are associated with much higher probability of introduction (e.g. planting) than others (e.g. processing). Whether the intended use of the commodity would destroy the pest or whether the processing, planting or disposal might be done in the vicinity of suitable hosts or habitats.

3.3.3. Establishment potential

Pest Establishment is defined as the "*Perpetuation, for the foreseeable future, of a pest within an area after entry"* (FAO, 1995; IPPC, 1997). Two key factors are generally of central importance in determining whether a pest can establish in an area:

- Host plants and suitable habitats;
- Climatic suitability.

Other key factors may also influence the perpetuation of the pest:

- Alternate hosts and other essential species, e.g. vectors if relevant;
- Other abiotic factors, e.g. soil type if relevant;
- Interspecific competition and predators or parasites;
- Conditions created by management of the environment;
- Suitability of protected cultivation if relevant.

The evaluation of Establishment Potential is usefully considered in two parts:

1. identification of the area of potential establishment; and
2. assessment of the suitability of this area for potential establishment.

In the first part the objective is to build up a map (if possible, literally) of the area of potential establishment. This area is the intersection of the areas defined by each of the factors listed above, i.e. the area where hosts are available AND climate is suitable AND any required species are present AND other abiotic factors are suitable... If the PRA area is sufficiently small, the outcome may be the whole of the PRA area but if the area is large, e.g. the whole of the EU, then many pests are likely to be restricted to parts of the PRA area. It can be defined eco-climatically, geographically, by crop or by production system (e.g. protected cultivation such as glasshouses) or by types of ecosystems. This first part is therefore an essential prerequisite to the second part, so that by focusing only on that defined fraction of the PRA area which is suitable for establishment, an assessment is provided for this defined area.

In the second part, the factors should be revisited but this time focusing on the area suitable for establishment, so in considering hosts and suitable habitats, the abundance and patchiness of the distribution of host plant species or suitable habitats should be considered. A similar appraisal should be made for alternate hosts and other species critical for the pest's life cycle.

The extent to which the climate is suitable in the area for potential establishment can be judged using pest distribution maps and maps of world climate zones (e.g. the Köppen-Geiger zones) to identify the climates where the pest is currently present. These can be compared with the climates in the area for potential establishment. Those areas where the host is present but not the pest may in some cases suggest climatic unsuitability. It is important to take into account the fact that the relationship between the current pest distribution and climate may not be clear because:

a) the current pest distribution is poorly known,
b) the species is still spreading,
c) the limits to its distribution depend on factors such as discontinuity in the presence of hosts or geographical barriers, e.g. the sea or mountains, rather than climate;
d) climate, as measured at weather stations, is not directly equivalent to the microclimate inhabited by the pest.

In addition to climate, other abiotic factors are sometimes important determinants of establishment, e.g. the physical and chemical characteristics of the soil, environmental pollution, topography, pH, salinity, water flow, where appropriate. Biotic factors which may influence establishment include the possibility of inter-specific competition from existing species, and/or predators or parasites already present in the area.

The favourability of the managed environment for establishment factors may be influenced by cultivation practices such as the time of year that the crop is grown, soil preparation, method of planting, irrigation, surrounding crops, time of harvest, method of harvest, soil water balance, fire regimes, disturbance, etc. Factors to consider for plants which are themselves the pest are for instance the regular mowing of road sides, cleaning of water courses, etc. Existing pest management practice should also be considered.

Where a pest cannot establish outdoors in the PRA area, the relevant host may be grown under protected conditions, e.g. glasshouses providing protection from adverse environmental extremes. The pest may already have been recorded in protected cultivation elsewhere or outdoors in warmer regions of the world.

The biological characteristics of the host, e.g. the reproductive strategy, whether the pest life cycle is compatible with conditions in the PRA area and adaptability of the pest may be important in some cases. Pests which are able to withstand environmental fluctuations, to adapt to a wider range of hosts or cultivars or develop resistance to plant protection products may have increased the potential for establishment in the future, requiring re-assessment within a relatively short time-frame. Examples of high adaptability include *Bemisia tabaci* which clearly seems to be able to evolve quickly to produce new biotypes, to develop insecticide resistance and to expand its host range and *Phytophthora ramorum*, which also appears to be rapidly increasing its host range. Evidence that a pest has previously established in new areas outside its original area of distribution may suggest increased risk to the PRA area, depending on the similarity of the situations.

3.3.4. Spread potential

Spread is defined as the "*Expansion of the geographical distribution of a pest within an area"* (FAO, 1995). The extent and rate of this expansion is an important determinant of the potential impact of a pest; if spread is minimal then physical impact will obviously be restricted to a small area. If the impact is legislative, e.g. a restriction of movement of produce as part of an eradication campaign, then the impact may not be proportional to extent of spread. Developing a standard approach to the assessment of spread is not easy because different taxa often spread on different timescales and also by different means and exhibit different patterns. Some pests spread on an expanding front whist other exhibit 'jump-spread' to create new foci of infestation; some do both. In characterizing pest spread, therefore, it may be helpful to consider the different possible mechanisms of spread and also to describe spread in terms of the potential area of expansion on different time scales as well as the rate of expansion of the area. Where spread occurs as an advancing front of incidence or infestation, spread can be described as distance advanced by a pest or disease front per unit time (e.g. 50 m/year).

The mechanism of spread can be broadly divided into Natural and Human-assisted. Natural population spread can result from the movement of the pest actively or passively by wind or water, transport by vectors such as insects, birds or other animals (internally

through the gut or externally on the fur), or by movement of an organism through soil, e.g. rhizomial growth.

Human-assisted spread can result from movement associated with commodities, packing materials, baggage, mail or conveyances. For intentionally introduced plants spread to the unintended habitat may be the relevant hazard. For certain pests, agricultural practices such as grafting, budding and contamination of hands, clothing and tools used for pruning, cutting, thinning and preparing the soil commonly causes spread over short distances within the place of production. Movement of people and machinery over larger distances and between production sites may cause spread over larger distances. Evidence of mechanical or soil-borne transmission of pest may indicate the potential for at least moderate spread.

Spread can usefully be described in terms of the area colonized by the pest. Left unchecked the pest might be expected to spread until it reaches some limit dependent on similar factors to those determining the area suitable for establishment. Expectations of the area colonized must therefore be considered over a specific timeframe and can be expressed in two ways, either:

- the time needed for the pest to reach its maximum extent in the PRA area; or
- the proportion of the area of potential establishment invaded by the pest after X years, where X should be specified, e.g. 5 or 10 years. (It may be that a proportion of this area is already occupied by the pest at the time the assessment is performed).

As might be expected, the assessment of spread depends on many of the factors which also determine establishment. The difference is that here we are concerned not only with whether a pest population can exist in an area but also can it move. As with the other parts of the assessment, expert opinion is likely to be the basis for most assessments, backed up when available by the biological characteristics and life history of the pest, and experience from areas where the pest is present or has previously invaded. Useful insights might be obtained from evidence of spread by taxonomically or morphologically similar pests. In some instances models of the spread of similar pests may have been developed but should be treated with caution as they frequently calculate rates of spread for general situations which might be very different from those in natural heterogeneous landscapes with complex land-use patterns.

3.3.5. Eradication and containment

Whilst considering spread it may be useful also to consider the degree to which spread can be prevented by eradication or containment measures. Pests which are harder to eradicate or contain within a restricted area may pose a greater risk of impact, so as well as impinging on risk assessment directly, a general consideration of the potential for eradication or containment of the pest may be a useful precursor to the risk management phase of a risk analysis.

Survival of attempts at eradication is likely to depend on how early in the process of spread the measures are implemented. Some pests can be eradicated at any time, others at an early stage and others are very difficult to eradicate. Eradication may be difficult because a pest is difficult to find and determine its distribution. Similarly, containment of a pest outbreak within the PRA area can be rated with similar grades of potential difficultly.

Another situation which sometimes occurs is the occurrence of transient populations, most commonly at certain times of year when the climate is most favorable. Though a pest may be unable to maintain a year-round established population, seasonal incursions into the PRA area may nevertheless be of significant importance. These could occur through natural migration or spread from established populations or through man's activities (including intentional release).

3.3.6. Impact potential

Impact is related to spread so assessment of impact might usefully take account of both short-term and long-term effects. An option is to evaluate the impact for a particular time-frame (e.g. after 5 years) when it might be expected that a certain proportion of the area of potential establishment has been invaded (e.g. what would be the impact if 25% of the area was invaded by the end of 5 years?). Another approach would be to consider impact in terms of the entire area of potential establishment; this measure of impact would then be moderated in a final synthesis by the extent of spread expected in the desired timeframe.

The essential question is whether the introduction of the pest to the PRA area will have unacceptable consequences: economic, environmental or social. Expert judgement is likely to play a large role in the evaluation of the likely level of impact but economic estimates are also often possible if there is evidence to assume a certain percentage loss to a known area of host crop. Consideration of all hosts (or all habitats) and all situations may be too laborious, and the study of a single case may be sufficient if, for example, one host is particularly important. It may be possible to make general judgment which encompasses all hosts/habitats. If however different parts of the agricultural sector are likely to suffer widely differing impacts, it may be valuable to document this and assess impact to these sectors separately.

For a regulated pest, certain phytosanitary measures may currently be required so if the assessment is directed at possible deregulation (which would remove the requirement for these measures), impact should be assessed on the assumption that measures targeting the pest are withdrawn.

3.3.7. Economic consequences

If the economic consequences are to crops in the PRA area, the most important issues are likely to be:

1. the negative effect likely on yield and/or quality;
2. the increase in production and control costs that is likely to be caused;
3. the likely loss in domestic and export markets.

Realistically, producers are likely to use measures to protect the crop if these are feasible so the most useful assessment of impact is likely to include the assumption that all potential measures legally available to the producer are applied (but without phytosanitary measures). The assessment of Damage (1. above) and/or Cost (2. above) might need to take into account:

- existing and potential control measures and their efficacy against the pest;
- efficacy of plant protection products against this pest;

- resistance to plant protection products, difficulty to change cultural practices;
- occurrence of the pest 'refuges' in natural habitats, private gardens or amenity land;
- simultaneous presence of more than one stage in the life cycle making control more difficult;
- absence of resistant cultivars;
- surveillance and monitoring effort;
- general enterprise costs, e.g. labour.

The assessment of Market loss (3. above), might consider the size of the domestic market plus any export market for the plants and plant product(s) at risk. How much market loss is likely, e.g. as a result of trading partners imposing export bans from the PRA area? Exports may be particularly affected and it is useful to assess their importance by estimating:

- the proportion of the production going to different export markets;
- how likely each market is to impose an export ban from the PRA area;
- the resulting relative decrease in market size.

If any of these three impacts: Damage, Cost or Market loss, is considered to be major, then it is clear that a risk of very significant economic impact exists. If there are high levels of uncertainty or these impacts are judged to be less significant, then it may be useful to consider other aspects of potential economic impact:

- If control measures are unlikely to be applied then it is appropriate to consider the negative effect of the pest in the absence of control measures. Control measures may not be applied due to reliance on natural control, inability or disinclination to apply controls;
- Similarly if producers are thought unlikely to change their behaviour in response to the invasion of the pest concerned it is appropriate to consider the negative effect of the pest in the absence of any *additional* control measures;
- In discussing above the key issues of damage, cost and markets, consideration was not given to where these losses fall. Particular producers may suffer very large losses whilst the average loss across all producers may be relatively small. Losses may be transferred to consumers as higher prices. Producers may alter their operation to mitigate losses by growing other crops; consumers may switch to other commodities, etc. All these factors may alter the eventual economic outcome of a pest invasion;
- Possibility of disruption of existing biological or integrated systems for control of other pests;
- An increase in other costs resulting from introduction, e.g. enforcement, research, extension/education, advice, publicity, and certification schemes;
- An increase in the economic impact of other pests, e.g. if the pest can act as a vector or host for these pests or if undesirable genetic traits can be carried to other species.

3.3.8. Environmental consequences

There may be direct environmental effects of the pest including loss of / decrease in distribution / reduced viability of a keystone species or a threatened / endangered species. There may be indirect environmental effects including changes in habitat composition, loss of habitat or food for wildlife, changes in soil structure or water table, or changes in ecosystem processes.

As a specific approach to the assessment of environmental impact we consider in more detail that described in the latest version of the EPPO Decision Support Scheme for Quarantine Pests (EPPO 2011). A clear distinction is made between the assessment of pests whose likely impact in the PRA area can be evaluated from the impact seen in previously invaded areas and those that cannot.

The environmental impact caused by the pest within its current area of invasion is considered first, having potential use as an indicator of the potential environmental impact in the PRA area:

- If it is impossible to make such an assessment because the species has not invaded any other area then an assessment of a closely-related species may be useful, or an assessment of the target species in its region of origin. The latter may be of limited value however as the environmental impact of a pest in its region of origin is often a very poor predictor of potential impact in regions where it has been introduced;
- If it is possible to make an assessment, most relevant is the impact observed in regions that are most closely related, geographically and eco-climatologically, to the PRA region. Other regions may have limited applicability if:
    - the PRA area is likely to be more or less susceptible to environmental impact than the current area of invasion;
    - the conditions in the PRA area are not sufficiently similar to those in the area of invasion to expect a similar level of impact;
    - the native species communities, or the threatened ecosystem services are not the same in the PRA area as the current area of invasion.

In the current area of invasion it is possible to consider:

- Negative impact on native biodiversity, e.g. decline in native species; changes in the composition and structure of native species communities; hybridization with native species;
- Alteration of ecosystem processes and patterns, e.g. physical modifications of habitats; changes in nutrient cycling and availability; modifications of natural successions; disruption of trophic and mutualistic interactions;
- Conservation impacts, e.g. pest occurrence in habitats of high conservation value; harm to rare or vulnerable species.

When making a judgement for the PRA area directly, it is possible to consider:

- the potential impact on native plants dependent on whether the host range of the pest includes native plants in the PRA area and whether the damage is likely to be caused by the organism on its major native host plants in the PRA area;
- the impact on ecosystem patterns and processes dependent on the ecological importance of the host plants in the PRA area;

- Conservation impacts dependent on whether the host plants occur in ecologically sensitive habitats (includes all officially protected nature conservation habitats) and the potential for harm to rare or vulnerable species (includes all species classified as rare, vulnerable or endangered in official national or regional lists within the PRA area);
- Impact of pesticides if the presence of the pest would result in their increased use.

3.3.9. Social consequences

The social consequences of a pest introduction concern impacts on human well-being. There may of course also be a social dimension to economic and environmental impact but there may be other effects in addition to what can strictly be described as economic or environmental effects. Social impacts *per se* might include:

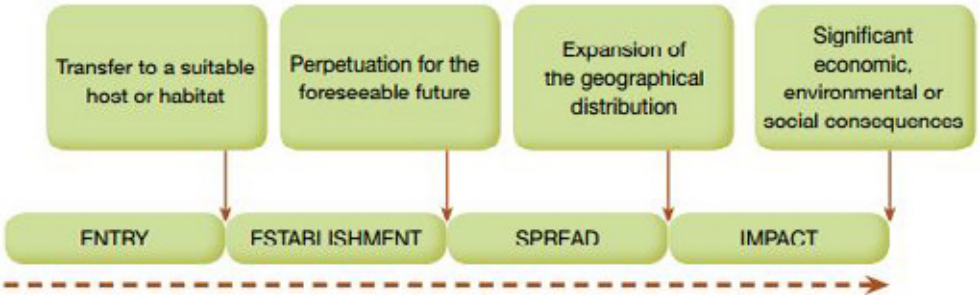
- Landscape effects, dependent on what land use types are affected, e.g. agriculture, living area, recreational area, and the contribution these land use types make to wellbeing because of their aesthetic, cultural or historic value. This includes both effects on local communities and tourists;
- Loss of employment, paralleled also probably by economic impact on the agricultural industry;
- Effects on human health, particularly in developing countries where alternative food sources may be difficult to substitute if crops are lost;
- Products and services such as water quality, animal grazing, hunting and fishing.

Following a similar logic to that used in environmental impact it may be valuable to evaluate the social impacts caused by the pest within its current area of distribution and within any previous are area of invasion as well as specifically for the PRA area.

3.4. Integrating the factors involved in the pest risk assessment

A thorough Pest Risk Assessment is a lengthy and detailed undertaking with a potentially large number of factors to consider. These factors have been discussed in the earlier sections. The process is none the less quite simple in concept having four essential steps. At each step, we estimate the likelihood that the pest will achieve that step and so move to the next one; all four steps are necessary for a risk to exist (Figure 4).

Figure 4: Transition points between the steps of a pest risk assessment



Each step is informed by a number of factors so it is helpful to consider how to weight or combine these in order to arrive at an overall assessment for each step. The integration is usually left to the judgement of PRA experts. Either individuals or panels of PRA practitioners therefore consider each particular case and according to evidence or judgements about the risk factors come to a judgement of the overall likelihood or consequence rating for each step. This approach is reasonable and is rightly regarded as providing the 'gold standard' in performing PRAs.

In two recent European projects, PRATIQUE (Baker *et al.*, 2009; 2012) and Prima phacie (Macleod *et al.*, 2010), supplementary or supporting methods where developed, ranging from descriptive tools designed to present risk factor information simultaneously and succinctly, to models to integrate the factor ratings using a general set of combination rules (Holt *et al.*, 2012).

An example of the output from descriptive tool, called the 'Visualizer', which was developed as part of PRATIQUE, is shown in Figure 5. It uses Excel-based software and allows users to visualize all the assessor inputs, check for consistency and uncertainty, compare between PRAs of different species, review previous PRAs, and provide double-check of the summary rating against all the individual factors which contribute to that rating. The Visualizer is intended to provide a common visual context for use in workshops and working groups. It performs no analysis as such but presents the very complex set of information contained in a PRA in a form that can be considered in a unified fashion.

The other method which was developed jointly in Prima Phacie and PRATIQUE is a model which integrates all the individual questions in the assessment through a hierarchy of rules that attempt to mimic the logic used by the assessors and are arranged in the

form of a flow chart to give an overall rating with an accompanying expression of uncertainty. Thus the often implicit general rules used in weighting and combining risk factors that are used by PRA experts were made explicit.

It is a rule-based model based on a hierarchical structuring of the problem into sub-concepts (represented by aggregate attributes) and finally into a finite set of basic attributes, the individual risk factors / PRA scheme questions. The model lends itself well to visualization as a flow chart. The rules for integrating the attributes are set out in a series of risk matrices which are familiar tools in a number of PRA schemes (USDA, 2000; Biosecurity Australia, 2001). Matrices express rules for the aggregation of concepts in a way that is readily defined and scrutinized by PRA practitioners. They are an attempt to express the logic of how assessors integrate information. Freeware software developed for Bayesian Belief Networks (GeNie2, 2010) is used for the model and this provides a convenient platform that also offers a helpful graphical presentation.

The 'Rule-based matrix model' (RBMM) goes a step further than the Visualizer by modelling the relationships between the variables to effectively mimic the evaluation processes used by experts and so provide a mechanistic explanation of their decision-making processes. The RBMM can capture the logic only for a general situation, and differences between the model and specific cases are therefore expected. The purpose of the model is to provide a consistent, repeatable methodology which should be regarded as a baseline to check the consistency of the summary ratings for each of the PRA sections for Entry, Establishment, Spread and Impact in new and existing PRAs (Schrader *et al.*, 2012).

The model for the Entry part of the scheme is used as an illustration (Figure 6). Other structures are possible, but that in Figure 6 gave model results that, in limited testing with experienced pest risk assessors, corresponded reasonably well to independent assessors' judgements of risk. The structures themselves are closely linked to the choice of matrices, as different structures imply different combination rules.

Figure 5: Screenshot of the 'Visualizer' showing the four steps of an EPPO PRA for an example species
There are five types of data integrated on a single graph: bubble positions give the risk factor ratings on a 1 to 5 scale (from very low to very high; very unlikely to very likely, etc.), bubble size is proportional to the uncertainty attached to the risk factor; bubble color represents risk factor sub-groups; dark grey bars the overall rating for that step in the risk assessment; paler grey bars the distribution representing the uncertainty associated with the overall rating for the step.

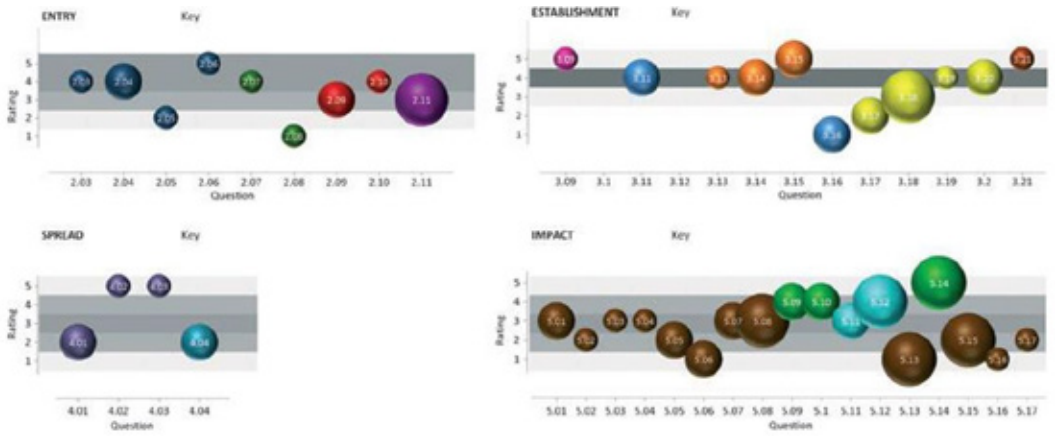
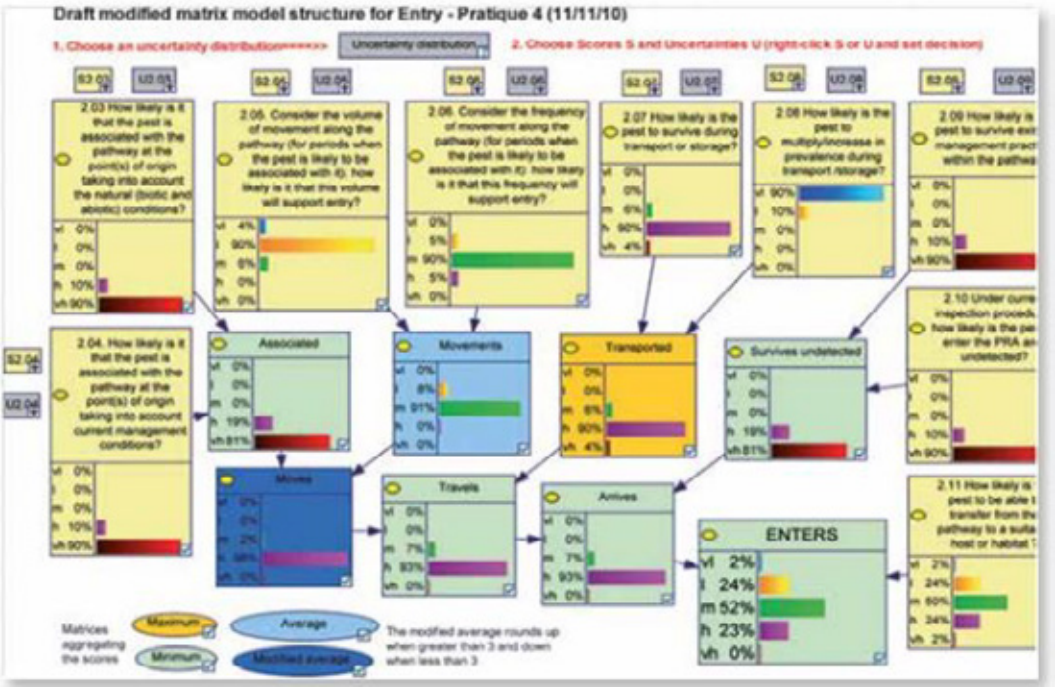


Figure 6: The Entry model as demonstrated in Hammamet, Tunisia, November 2010



It is important to stress that the definitive result of a Pest Risk Assessment should be based on expert judgement, not on the model. The model provides a general bench-mark for comparison but individual cases are expected to differ from the general case because certain factors may be more important in some cases that others – something which is impossible to take into account in a model representing the general logic of the PRA process.

Both the Visualizer and the Rule-based matrix models are available as part of the EPPO Decision Support Software for PRA (CAPRA, 2012).

3.5. Conclusion of a pest risk assessment

3.5.1. The outcome of pest risk assessment and link to risk management

The outcome of the pest risk assessment is a set of information designed to support risk management. Pest risk assessment concerns the gathering and evaluating of information. Importantly, it should document the conclusions drawn from the information made by the assessors about the aspects of pest risk.

In the course of the Pest Risk Assessment the process should have:

1. identified the PRA area;
2. identified and categorized the pest and pathways to be assessed;
3. estimated the pest's potential to be introduced, to cause harm, and consequently the overall potential risk posed by the pest;
4. indicated with supporting evidence whether the pest risk is acceptable or not, and if mitigation measures should be considered;
5. throughout the process, identified gaps in information, assumptions and consequent uncertainty.

Taking into account the uncertainties (5 above), if it is decided that the pest presents an acceptable level of risk (4 above), then there is no need to go further. For those pests which do present an unacceptable risk, the analysis should go on to consider Pest Risk Management. At the end of the Pest Risk Assessment the point is reached where it is decided whether some mitigation may be desirable. Pest Risk Management takes over the process of identifying and prioritizing what actions might be taken.

3.5.2. Assessment of risk reduction options within a pest risk assessment

The Pest Risk Management stage of the PRA may result in:

- either no appropriate measures being identified,
- or a selection of one or more management options that have the potential to lower the risk associated with the pest to an acceptable level.

Combinations of measures as opposed to a single measure may also be considered; this has been termed a *'systems approach'* (ISPM 14, 2002).

As indicated in Figure 2, there is a 'feed-back loop' from Pest Risk Management to Pest Risk Assessment. Where measures have been identified assessors may re-evaluate those specific risk factors which are likely to be mitigated were the measure to be implemented. For example, crop sanitation affecting pest survival during the growing of the commodity may reduce the level of association of the pest with the pathway, so altering the rating and uncertainty associated with question 2.04 as depicted in Figure 5

and 6. A series of Pest Risk Assessments taking into account one or more potential mitigation measures can then be performed in order to support the reasons for selecting preferred options. The management options may form the basis for phytosanitary regulations or requirements for action at any stage in the production chain which may be developed in the response to the risk presented by the pest.

3.5.3. Quality control and review

The PRA will usually form the basis for future actions by the NPPO, including development of regulations, implementation of phytosanitary measures on imported commodities, and surveillance, control or eradication measures taken within the NPPO. It is important therefore that the PRA is of sufficiently comprehensive, consistent and reliable. It should be subjected to a peer-review which should consider whether:

1. relevant information sources have been comprehensively searched, are up-to-date, correctly interpreted and properly referenced;
2. judgements made are justified, documented and referenced based on a PRA which is sufficiently detailed to support the conclusions and where uncertainties in the PRA have been taken into account;
3. the PRA is of a consistent standard with that of other PRAs previously conducted.

A PRA can only utilize the information available at the time but the environment in which it is performed is frequently highly dynamic. New information that becomes available may have an impact on the PRA decision and so revision may be required due for example to changes in: the distribution of the pest, trade routes or volumes, distribution of hosts in the PRA area, detection or control measures, changing policy or changing climate.

3.6. ISPM Standard No. 2: Guidelines for pest risk analysis

3.6.1. Endorsement

The following standard was endorsed by the 28th Session of the FAO Conference in November 1995.

3.6.2. Introduction

❑ Scope

This standard describes the process of pest risk analysis for plant pests for the purpose of preparing phytosanitary regulations by National Plant Protection Organizations.

❑ References

FAO Glossary of Phytosanitary Terms, FAO Plant Protection Bulletin 38(1), 1990: 5-23. International Plant Protection Convention, FAO, Rome, 1992.

Principles of plant quarantine as related to international trade, ISPM No. 1, FAO, Rome, 1995.

❑ Definitions

Definitions of phytosanitary terms used in the present standard can be found in ISPM No. 5 (Glossary of phytosanitary terms).

❑ Outline of requirements

Pest risk analysis (PRA) consists of three stages: initiating the process for analysing risk, assessing pest risk, and managing pest risk (see Figures 1-3). Initiating the process involves identification of pests or pathways for which the PRA is needed. Pest risk assessment determines whether each pest identified as such, or associated with a pathway, is a quarantine pest, characterized in terms of likelihood of entry, establishment, spread and economic importance. Pest risk management involves developing, evaluating, comparing and selecting options for reducing the risk. PRA is only meaningful in relation to a defined 'PRA area' considered to be at risk. This is usually a country, but can also be an area within a country, or an area covering all or parts of several countries (e.g. the area covered by a Regional Plant Protection Organization [RPPO]).

3.6.3. General requirements for pest risk analysis (PRA)

❑ Stage 1: Initiating the PRA process

There are generally two initiation points for a pest risk analysis (see Figure 1):

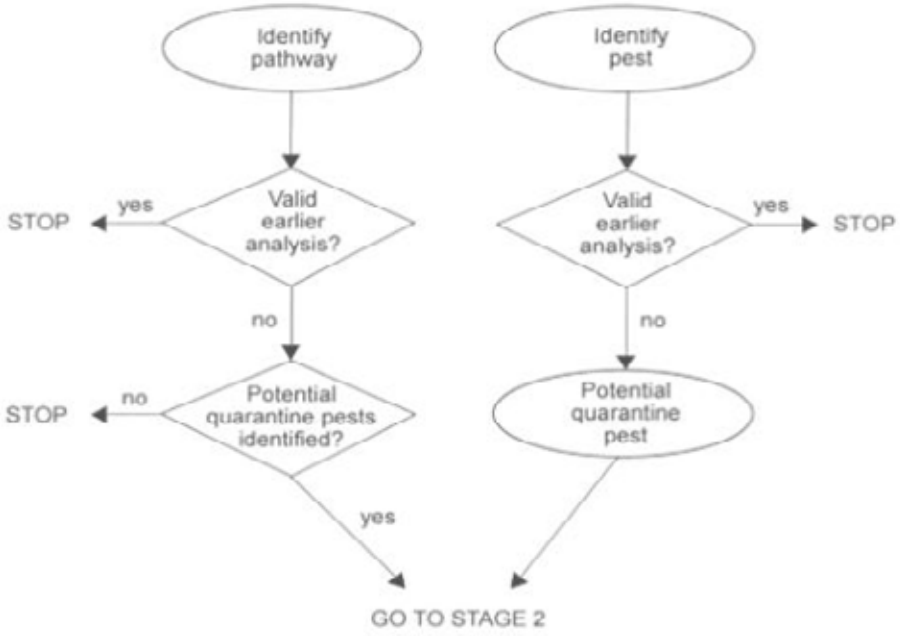
- the identification of a pathway, usually an imported commodity, that may allow the introduction and/or spread of quarantine pests;
- the identification of a pest that may qualify as a quarantine pest.

Either can involve pests already present in the PRA area but not widely distributed and being officially controlled, as well as pests absent from the PRA area, since both are covered by the quarantine pest definition.

1.1 PRA initiated by a pathway
A requirement for a new or revised PRA originating from a specific pathway will most frequently arise in the following situations:

- International trade is initiated in a new commodity (usually a plant or plant product) or a commodity from a new origin. The PRA may be triggered by a request for import, or by the appearance in trade of consignments of a commodity. The pathway may concern a single area of origin or several;
- New plant species are imported for selection and scientific research purposes;
- A pathway other than commodity import is identified (natural spread, mail, garbage, passenger's baggage etc.);
- A policy decision is taken to establish or revise phytosanitary regulations or requirements concerning specific commodities;
- A new treatment, system or process, or new information impacts on an earlier decision.

Figure 1: Pest risk analysis



The pests which are likely to follow the pathway (e.g. be carried by the commodity) are then listed, and each is then subjected to Stage 2 in the PRA process. [1] If no potential quarantine pests are identified as likely to follow the pathway, the PRA stops at this point.

1.2 PRA initiated by a pest

A requirement for a new or revised PRA originating from a specific pest will most frequently arise in the following situations:

- An emergency arises on discovery of an established infestation or an outbreak of a new pest within a PRA area;
- An emergency arises on interception of a new pest on an imported commodity;
- A new pest risk is identified by scientific research;
- A pest is introduced into a new area other than the PRA area;
- A pest is reported to be more damaging in a new area other than the PRA area itself, than in its area of origin;
- Audits reveal that a particular pest is repeatedly intercepted;
- A request is made to import, as such, an organism, for example by researchers, educators, biological practitioners, businesses (pet store owners), the food industry (snails for consumption) or hobbyists (aquatic plants for aquaria);
- A policy decision is taken to revise phytosanitary regulations or requirements concerning specific pests;
- A proposal is made by another country or by an international organization (RPPO, FAO).
- A new treatment system, process, or new information impacts on an earlier decision.

The specific pest identified is then subjected to Stage 2 in the PRA process.

1.3 Review of earlier PRAs

Prior to proceeding with a new PRA, a check should be made as to whether the pathway or pest has already been subjected to the PRA process, either nationally or internationally. If a PRA exists, its validity should be checked as circumstances may have changed. The possibility of using a PRA from a similar pathway or pest, that may partly or entirely replace the need for this PRA, should also be investigated.

1.4 Conclusion for Stage 1

At the end of Stage 1, pests have been identified as potential quarantine pests, individually or in association with a pathway.

[1] The list of pests may be generated by any combination of databases, literature sources, or expert consultation. Once the list of pests has been established, it is preferable to prioritize it by using expert judgement before the next step. According to the results obtained, it may or may not be necessary to conduct a risk assessment on all pests on the list.

❑ Stage 2: Pest Risk Assessment

Stage 1 has identified a pest, or list of pests (in the case of initiation by a pathway), to be subjected to risk assessment. Stage 2 considers these pests individually (see Figure 2). It examines, for each, whether the criteria for quarantine pest status are satisfied: "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".

In this context, 'area' should be understood to mean:

> "an officially defined country, part of a country, or all or part of several countries",

and "endangered area" should be understood to mean:

> "an area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss".

In doing so, the PRA considers all aspects of each pest and in particular actual information about its geographical distribution, biology and economic importance. Expert judgement is then used to assess the establishment, spread and economic importance potential in the PRA area. Finally, the potential for introduction into the PRA area is characterized.

In characterizing the risk, the amount of information available will vary with each pest and the sophistication of the assessment will vary with available tools. For example, one country may have elaborate pest databases and geographical information systems, another may depend on books, printed soil maps, and climate maps. In some cases, virtually no information may be available, or research may be needed to obtain it. Assessments will be limited by the amount of information available on the biology of a particular pest. Countries where the pest is present may provide available information for the country conducting the PRA, on request.

2.1 Geographical and regulatory criteria

For each pest subjected to the PRA process, the geographical and regulatory criteria in the quarantine pest definition should be considered:

- If the pest is present in the PRA area and has reached the limits of its ecological range (*i.e.* is widely distributed), then the pest does not satisfy the definition of a quarantine pest and the PRA for the pest stops at this point.
- If the pest is present in the PRA area and has not reached the limits of its ecological range (*i.e.* not widely distributed), and the pest is subject to official control in the PRA area, then the pest satisfies this aspect of the definition of a quarantine pest.
- If the pest is not widely distributed but is under consideration of future official control in the PRA area, then the PRA will determine whether the pest should be placed under official control. If the conclusion is reached that the pest should be subject to official control, then the pest satisfies this aspect of the definition of the definition of a quarantine pest.
- If the pest is not widely distributed but is not subject to official control or consideration of future official control in the PRA area, then the pest does not satisfy the definition of a quarantine pest and the PRA for the pest stops at this point.
- If the pest is absent from the PRA area, then it satisfies this aspect of the definition of a quarantine pest.

2.2 Economic importance criteria

For potential economic importance to be expressed, a pest must become established and spread. Thus the risk of a pest, having entered, becoming established and spreading in the PRA area must be characterized. The factors to be considered are set out below.[2]

2.2.1 Establishment potential

In order to estimate the establishment potential of a pest, reliable biological information (life cycle, host range, epidemiology, survival etc.) should be obtained from the areas where the pest currently occurs. The situation in the PRA area can then be carefully compared with that in the areas where it currently occurs and expert judgement used to assess the establishment potential. Case histories concerning comparable pests can usefully be considered. Examples of the factors to consider are:

- availability, quantity and distribution of hosts in the PRA area;
- environmental suitability in the PRA area;
- potential for adaptation of the pest;
- reproductive strategy of the pest;
- method of pest survival.

If a pest has no potential for establishment in the PRA area, then it does not satisfy the definition of a quarantine pest and the PRA for the pest stops at this point.

2.2.2 Spread potential after establishment

In order to estimate spread potential of the pest, reliable, biological information should be obtained from areas where the pest currently occurs. The situation in the PRA area can then be carefully compared with that in the areas where the pest

[2] Fuller checklists of information which can usefully be considered in assessing the potential for establishment, spread and economic importance, are available from national and international sources.

currently occurs and expert judgement used to assess the spread potential. Case histories concerning comparable pests can usefully be considered. Examples of the factors to consider are:

- suitability of the natural and/or managed environment for natural spread of the pest – movement with commodities or conveyances;
- intended use of the commodity;
- potential vectors of the pest in the PRA area;
- potential natural enemies of the pest in the PRA area.

The information on spread potential is used to estimate how rapidly a pest's potential economic importance may be expressed within the PRA area. This also has significance if the pest is liable to enter and establish in an area of low potential economic importance and then spread to an area of high potential economic importance. In addition it may be important in the risk management stage (see Figure 3) when considering the ease with which an introduced pest could be contained or eradicated.

2.2.3 Potential economic importance

The next step in the PRA process is to determine whether the pest is of potential economic importance in the PRA area.

In order to estimate the potential economic importance of the pest, information should be obtained from areas where the pest currently occurs. For each of these areas, note whether the pest causes major, minor or no damage. Note whether the pest causes damage frequently or infrequently. Relate this, if possible, to biotic and abiotic effects, particularly climate. The situation in the PRA area can then be carefully compared with that in the areas where the pest currently occurs. Case histories concerning comparable pests can usefully be considered. Expert judgement is then used to assess the potential for economic importance. Examples of the factors to consider are:

- type of damage;
- crop losses;
- loss of export markets;
- increases in control costs;
- effects on ongoing integrated pest management (IPM) programmes;
- environmental damage;
- capacity to act as a vector for other pests;
- perceived social costs such as unemployment.

If a pest has no potential economic importance in the PRA area, then it does not satisfy the definition of a quarantine pest and the PRA for the pest stops at this point.

2.3 Introduction potential

The final stage of assessment concerns the introduction potential which 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. Potential pathways which may not currently exist should be assessed if known.

The following is a partial checklist that may be used to estimate the introduction potential divided into those factors which may affect the likelihood of entry and those factors which may affect the likelihood of establishment.

Entry:

- opportunity for contamination of commodities or conveyances by the pest;
- survival of the pest under the environmental conditions of transport;
- ease or difficulty of detecting the pest at entry inspection;
- frequency and quantity of pest movement into the PRA area by natural means;
- frequency and number of persons entering from another country at any given port of entry.

Establishment:

- - number and frequency of consignments of the commodity;
- - number of individuals of a given pest associated with the means of conveyance;
- - intended use of the commodity;
- - environmental conditions and availability of hosts at the destination and during transport in the PRA area.

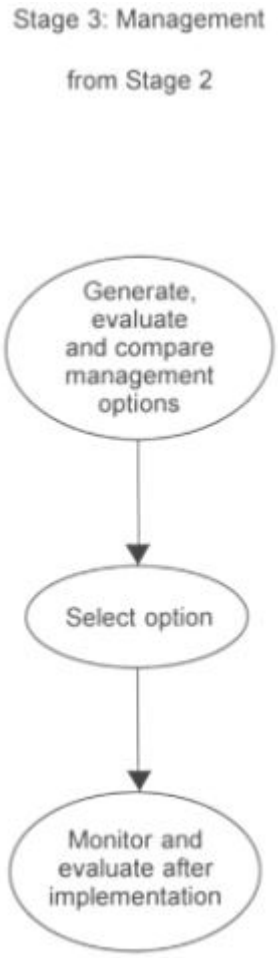
2.4 Conclusion for Stage 2

If the pest satisfies the definition of a quarantine pest, expert judgement should be used to review the information collected during Stage 2 to decide whether the pest has sufficient economic importance and introduction potential, i.e. sufficient risk, for phytosanitary measures to be justified. If so, proceed to Stage 3; if not, the PRA for the pest stops at this point.[3]

❑ **Stage 3: Pest Risk Management**

Pest risk management (see Figure 3) to protect the endangered areas should be proportional to the risk identified in the pest risk assessment. In most respects it can be based on the information gathered in the pest risk assessment. Phytosanitary measures should be applied to the minimum area necessary for the effective protection of the endangered area.

[3] Decision-making schemes, or expert systems, may be useful at this stage to assist expert judgement.



3.1 Risk Management Options

A list of options for reducing risks to an acceptable level should be assembled. These options will primarily concern pathways and in particular the conditions for permitting entry of commodities. Examples of the options to consider are:

- inclusion in list of prohibited pests;
- phytosanitary inspection and certification prior to export;
- definition of requirements to be satisfied before export (e.g. treatment, origin from pest free area, growing season inspection, certification scheme);
- inspection at entry;
- treatment at point of entry, inspection station or, if appropriate, at place of destination;
- detention in post-entry quarantine;
- post-entry measures (restrictions on use of commodity, control measures);
- prohibition of entry of specific commodities from specific origins.

They may also, however, concern ways of reducing the risk of damage, for example, introduction of a biological control agent, or ease of eradication or containment.

3.2 Efficacy and Impact of the Options
The efficacy and impact of the various options in reducing risk to an acceptable level should be evaluated, in terms of the following factors:

- biological effectiveness;
- cost/benefit of implementation;
- impact on existing regulations;
- commercial impact;
- social impact;
- phytosanitary policy considerations;
- time to implement a new regulation;
- efficacy of option against other quarantine pests;
- environmental impact.

The positive and negative aspects of the options should be specified. While it is recognized that countries according to the sovereignty principle may exercise their sovereign right to utilize phytosanitary measures, countries should also take particular note of the 'Minimal impact' principle:

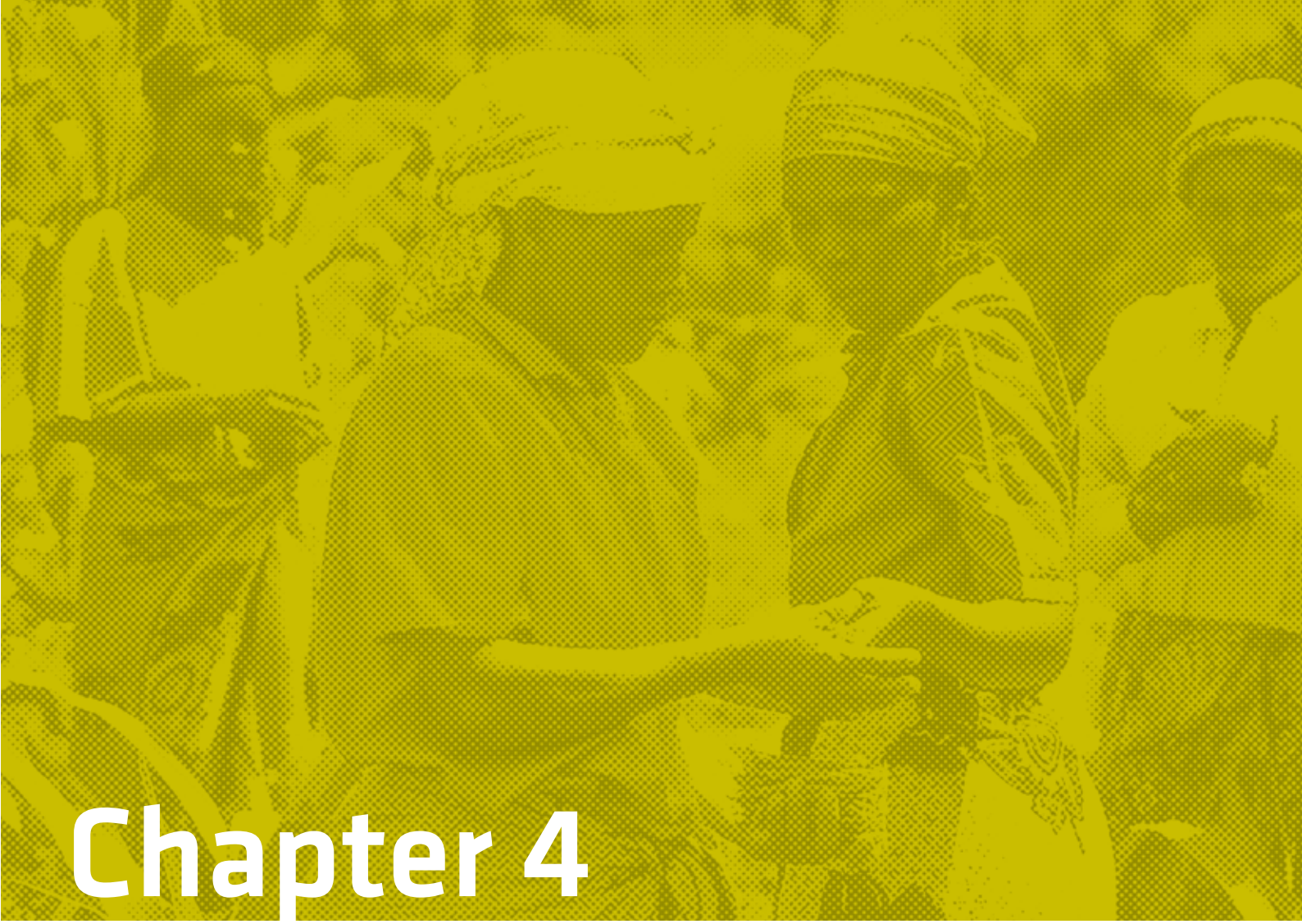
> *Phytosanitary measures shall be consistent with the pest risk involved, and shall represent the least restrictive measures available which result in the minimum impediment to the international movement of people, commodities and conveyances.*

Article VI.2(f) of the International Plant Protection Convention makes a similar but less comprehensive provision. Phytosanitary measures recommended should be based on all of the above factors. In order to determine which options are appropriate, it may be advisable to communicate with interested and affected groups within and outside the PRA area.

3.3 Conclusion for Stage 3
Completion of Stage 3 is essential; it is in particular not justified to complete only Stages 1 and 2 and then take phytosanitary measures without proper assessment of risk management options. After implementation of the phytosanitary measures, their effectiveness should be monitored and the risk management options should be reviewed, if necessary.

3.6.4. Documenting the PRA Process

A PRA should be sufficiently documented so that when a review or a dispute arises, the PRA will clearly state the sources of information and the rationales used in reaching a management decision regarding phytosanitary measures taken or to be taken.



Chapter 4

Surveillance and detection of plant pathogens and pests in the field

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General information about pests, diseases and weeds 94
Crop infestation, damage in production and at post-harvesting stage 96
Methods of observing and sampling pest populations in the field 98
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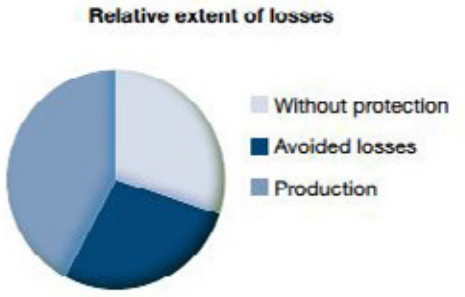
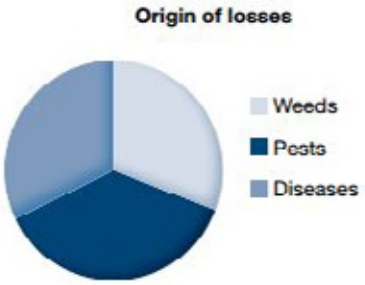
4.1. Extent of crop enemies and need to protect them

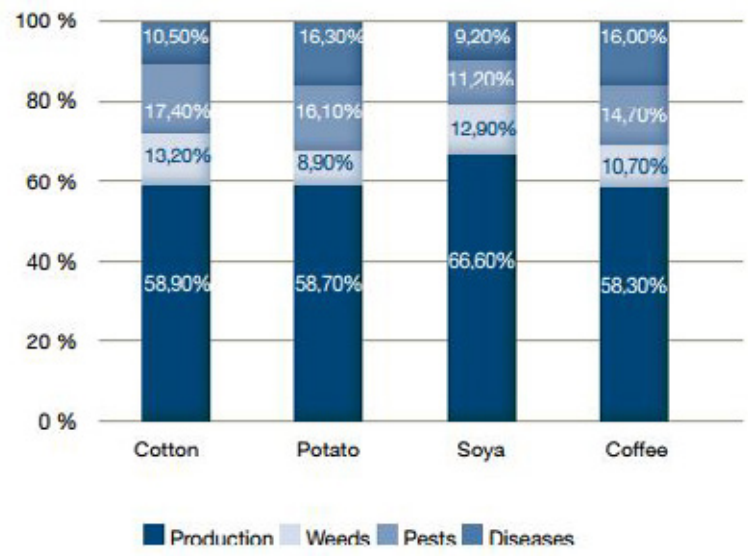
As a result of the combined action of diseases, attacks from pests and competition from weeds, it is estimated that almost **50% of world agricultural production** is lost before or after harvest. Estimated losses, per region and per crop, published in 1965 by H.H. Cramer were reviewed in 1990 by E.C. Oerke *et al.* for the 8 largest crops (cotton, soya, rice, maize, potato, coffee, wheat and barley).

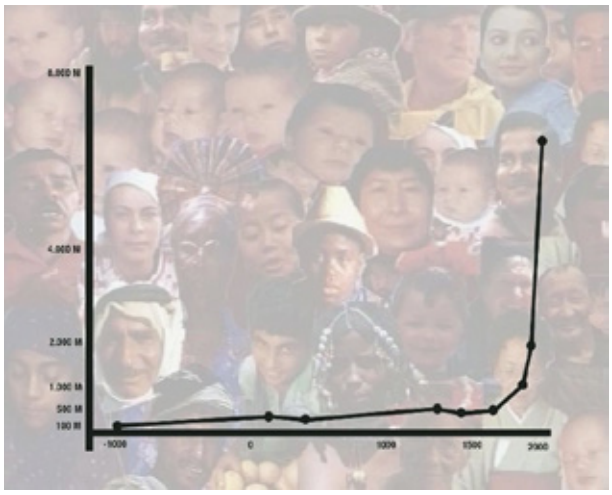


They reveal the **substantial difference** that exists between the "production potential" of the varieties used and the "outputs actually recorded", attributing it mainly to the damage caused to crops by pests, even in regions where the most up-to-date agronomic techniques are used.



Thus, Oerke estimates that the drop in production is comparable from one region to another when modern production techniques are used, but without any protection strategy. With cotton, for example, output may drop to 15.9% of potential production, compared with 60% currently achieved using various methods of protection.





The explosion of demographic growth over the last few decades, will continue until at least 2100, with the world population rising from over 6 billion to approximately 11.5 billion human beings at the end of the 21st century. What is more, the average increase in the standard of living in some regions where economic growth is strong and rapid also leads to an increase in the world's food needs.

However, there are only two ways of increasing production: **increasing the cultivated surface area, on the one hand**, and **improving productivity per hectare on the other hand**.

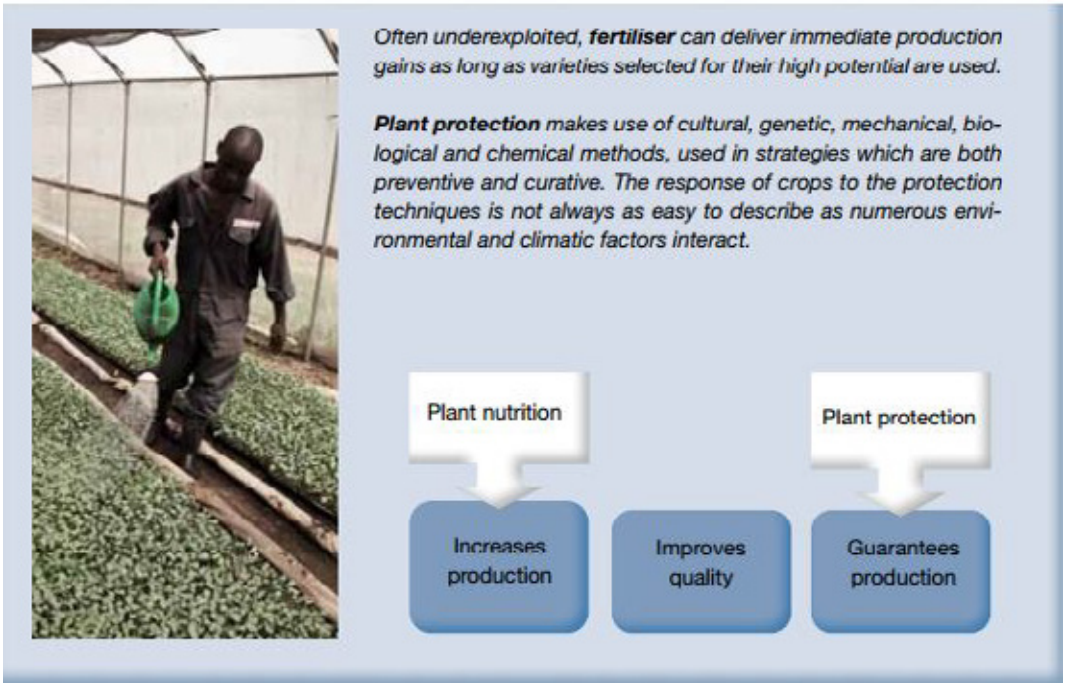
Depending on the type of economy in which they operate, and the economic context in which they live, farmers – whose aim is to secure a decent and increasing income for themselves (which is not necessarily the result of maximum productivity per hectare) – exploit one or other of these factors if they can. So, as long as land that is easy to cultivate is available, it may be more advantageous for them to increase the ground they cultivate than to make use of more inputs (fertilizer and pesticides).

Nevertheless, in practically every region of the world, **farmers are now faced first of all with a limitation of arable land available, and secondly with a drop in soil fertility (deterioration of soil, erosion)**.

This means that the only option they have in the medium and long term is **to increase productivity per hectare** and to **reduce post-harvesting losses**.

In developing countries, food-producing resources, and cereal crops in particular, will have to increase by around 70% by 2020, if the estimated 6.5 billion inhabitants are to be assured dietary security.

Almost all this increased food supply will have to come from countries that are themselves under development. To meet this forecast increase, it will be necessary to see a sustainable increase in the outputs of the main crops of cereals and leguminous plants, and a reduction in farming losses caused by pests and diseases.



Since the possibilities of expanding irrigation and areas suitable for arable farming are limited, **future strategies** ought to be based on **increasing the productivity of the ground and the water resources available**. Undoubtedly, there is no more extensive wastage of these resources than investing time, money and labour in food production only to see these crops swept aside, completely or partially, by infestations with pests, diseases and weeds (see table). Depending on the level of the losses and costs concerned, improving plant health control seems to be an important strategic means of increasing the food resources in existence in developing countries.

Actual production and estimated losses of eight harvests from 1988 to 1990, per parasite and per region (in US $ billions)

Region	Actual production	Causes of losses			
		Pathogens	Insects	Weeds	Total
Africa	13.3	4.1	4.4	4.3	12.8
North America	50.5	7.1	7.5	8.4	22.9
Latin America	30.7	7.1	7.6	7.0	21.7

Asia	162.9	43.8	57.6	43.8	145.2
Europe	42.6	5.8	6.1	4.9	16.8
Former Soviet Union	31.9	8.2	7.0	6.7	22.1
Oceania	3.3	0.8	0.6	0.5	1.9

Source: E. Oerke et al.*, "Crop production and crop protection: Estimated losses in major food and cash crops" (Amsterdam, Elsevier, 1995).*

However, the **incomplete information about the actual losses caused by parasites** and the actual and potential gains of plant health control constitute a great hindrance to formulating a strategy intended to improve plant health control. If all the losses caused by parasites rise to 50%, as indicated by certain researchers, States and organizations such as the World Bank and the CGIAR (*Consultative Group on International Agricultural Research*) must undoubtedly devote more resources to reducing these losses.

Recourse to the inputs available (fertilizers and pesticides) may considerably increase production, and consequently reduce the need to cultivate 'marginal' land, protecting the most fragile ground from deforestation, erosion and rapid degradation.

However, when output makes progress thanks to input, selection of variety, irrigation and improvement of crop protocols, the crops also become **more attractive** for the pests and often **more sensitive** to disease or to competition from weeds.

In order to safeguard the production potential, this leads to the need to use effective methods of monitoring and protecting the crops.

4.2. General information about pests, diseases and weeds

A cultivated field or plot constitutes an artificial environment where natural biodiversity has largely disappeared. By concentrating the cultivated species, the farmer encourages populations of pests and epidemics responsible for reducing the output per hectare of the crop. The damage caused to agricultural production and stored foodstuffs by pests, diseases and weeds often represents **over a third of the harvest**.

The agents responsible for these significant losses are mainly **plant-eating insects,** which are easily the most harmful: **nematodes, fungi, viruses and bacteria, not forgetting weeds.** Strategies for protecting crops and methods of controlling these pests are then needed in order to maintain a high level of production.

Pests of the main crops world-wide
(Source: Bayer CropSciences, List of pests, 2001)

Cotton	whitefly, bugs, leaf hoppers (especially dangerous because they are vectors of viral disease), *heteroptera*, *helicoverpa* caterpillars
Maize	wireworm, fruit fly, bug (as vector of viral disease)
Cereals	bugs (especially dangerous because they are vectors of viral disease)
Leguminous crops	bugs, whitefly, leaf hoppers, thrips, caterpillars attacking the leaf and the fruit, leaf miners
Ornamental plants	bugs, whitefly
Rice	leaf hoppers, web moth (*Sparganothis pilleriana*) of rice, aquatic weevil, leaf roller
Stone fruits	bugs, mealy bugs, leaf miners, codling moths, winter moths
Citrus fruits	mealy bugs, bugs, leaf miners, white fly, jumping plant lice
Potato	bugs (especially dangerous as vector of viral diseases), leaf hoppers, Colorado potato beetle
Rape	blossom beetles, stem flea beetles, weevils
Banana plant	Nematodes

Fungal disease affecting the main crops in the world (Source: Bayer CropSciences, List of pests, 2001)

Cereals	powdery mildew, rust fungus, rhynchosporiosis, septorioses (septoria), and brown spot disease, rot and smut
Rice	pyriculariosis (pyricularia), rhizoctoniae and other diseases of the leaf
Leguminous crops	infected seeds, rust fungus, rotting of fruits and leaves, grey mould, powdery mildew and mildew, diseases of the foliage and the fruits (e.g.: alternariosis, cercosporiosis, etc.)
Potato	mildew, rhizoctonia, silver scurf
Vine	powdery mildew and mildew, grey mould
Pome fruits	scab, mildew, monilia
Stone fruits	monilia
Mango	cercosporiosis
Peanuts	rhizoctonia, sclerotiniosis, cercosporiosis, rust
Banana plant	cercosporiosis (Sigatoka disease affecting the leaf system of the banana plant)
Rape	sclerotiniosis, phoma lingam
Coffee plant	coffee rust

However, a rational and effective fight against crops, pests and diseases **involves minimum knowledge of their lifestyle, their biology and their principal characteristics** in order to be able to identify them both with certainty and as quickly as possible on the basis of the symptoms observed, for an effective and profitable response.

4.3. Crop infestation, damage in production and at post-harvesting stage

Threats to crop production can arise at an **early stage**, from sowing onwards. **Seeds** that are healthy, high quality and disinfected (not affected by viruses, free from all types of bacteriosis and not colonized by the larvae of insect pests) must be used and **seedbeds** must be maintained under good, healthy conditions, free from nematodes, viruses, insects carrying disease, etc.

Inadequate growing practices (choice of plot and type of soil, inadequate rotation, destruction of beneficial insects, poor weeding and elimination of debris from crops after harvesting, contaminated ploughing tools, harsh pruning etc.) may also be responsible for massive infestation.

Frequent phytosanitary inspections of plots and orchards, the use of traps, regular soil analyses, clearing weeds from seedlings, observing diseased plants are all necessary in order to detect the start of attacks, to monitor them and if necessary halt their development.

- **Gnawing insects** devour the different parts of the plants (caterpillars of the Lepidoptera family, larvae and adult Coleoptera, grasshoppers and crickets of the Orthoptera family). **Biting-sucking insects** suck up the sap from plants and weaken them. They are also vectors of viruses (whitefly, mealy bugs, zigzag leaf hoppers, greenfly, bugs, thrips). Certain insectscause damage to plants because they lay eggs. The development of the larva in the plant tissues is accompanied by consumption of these tissues (fruit flies, leaf-miners that dig tunnels in the leaves). As for underground insects, they attack the roots and tubercles (mole crickets, grey worms). Insects may also be responsible for considerable damage to stored foodstuffs (grains, flour, meat etc.). Some insects, which are recognized as ‘quarantine organisms’ must be detected in harvested products (ideally prior to their dispatch).

- **Fungi and bacteria** penetrate through the roots, stalks, leaves and fruits through cuts and natural openings, or directly through intact surfaces, resulting in the appearance of marks of different colours or rotting. This damage makes fruit and vegetables unsuitable for consumption and may occur both when they are growing and after harvest. Numerous fungi and bacteria are responsible for post-harvesting damage and most viruses infect fruit and vegetables during the growing period and develop during storage, especially under favourable storage temperature conditions. Excluding the direct damage they cause to plants and fruit and vegetables, fungi may also contaminate foodstuffs with the toxins (“mycotoxins”) they release or by inducing in plants products of natural defence (‘phytoalexins’). Some of these compounds are particularly dangerous to

consumer health even at low concentrations (regulations on acceptable concentrations have been fixed by the European Commission). The invasion of stored products by fungi, thanks to favourable conditions (temperature and/or humidity too high) is generally the cause for contamination by mycotoxins such as aflatoxins or ochratoxins.

- **Nematodes** invade the roots which swell (galls) and the root system becomes nodular; secondary roots develop and the supply of water and nutritional elements no longer takes place: the plant becomes stunted, yellows and withers. In fact, water absorption is very often 'impaired'. Assimilation of potassium is reduced, as well as that of sodium, at times. Often a higher concentration of the other mineral elements can be observed in the aerial organs. In the potato, *Ditylenchus destructor* causes a reversal of the relative levels of sucrose and starch.

- As for **weeds**, these may be directly harmful to the crop as they may compete for nutritional elements and water, from the moment the cultivated plant begins to develop. Consequently, this affects the assimilation of chlorophyll in the cultivated plant and therefore its growth. In addition, some weeds grow faster than the crop that has been planted and may therefore be responsible for stifling the developing plant. Finally, weeds may house various parasites (viruses, bacteria, fungi and insect pests) and may therefore be a source of infestation.

Hence the damage caused by the various plant pests and parasites, both when growing and during post-harvest storage, are numerous and vary in importance depending on the state of infestation, the robustness of the plant and the early nature of the intervention which must remain effective and compliant with quality and environmental regulations.

The type of treatment (plant health control) must be appropriate, and must take into consideration the following:

- the organisms to be controlled (efficacy);
- the sensitivity of the crops (selectivity);
- the aim pursued (to limit development, prevent an infestation, eradicate a pest or a disease etc.);
- regulatory requirements (plant control regulations) and those of specifications (quality standards);
- the skill of the operators;
- safe use and means of protection of personnel;
- targets of competitiveness (profitability of control);
- impact on the environment (durability, protection of bees etc.).

4.4. Methods of observing and sampling pest populations in the field

The word 'population' is used to refer to all individuals of the same species that occupy a territory (the biotope). The limits of this territory are generally the local geographic region to which this species belongs.

The populations possess a set of characteristics such as the spatial distribution of the individuals, the density, the structure, and so on. The **density of a population** is the number of individuals present per unit of surface area or volume.

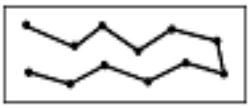
Determining population density is important as **the damaging effect of a species in an environment largely depends on its density**… with notable exceptions such as virus vectors!

The methods of evaluating the density of populations, essential for establishing a control strategy, are extremely numerous and may be grouped under 2 main headings: **direct counting** and **indirect methods** (**trapping, extraction etc.**), not forgetting the techniques of diagnosis and sampling.

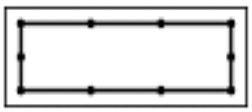
Choosing a sampling method is a complex process which must be adapted to suit the type of crop being observed. The main stages the observer must carry out are as follows:

1) planning the regularity of recording in line with the pest, the disease or the weeds being targeted and keeping to a schedule of observation and sampling activities;
2) determining the units (e.g.: plants, leaves, roots, etc.) and drawing up a plan of the farm's plots (in order to determine the areas to investigate);
3) determining the pest counting, evaluation and location techniques to be used. Three techniques are mainly used:
    - counting the pests present according to the different stages of development;
    - observing the damage caused by pests and/or the symptoms caused by diseases;
    - counting the number of seedlings with insects, acarids, nematodes etc., or that show damage, or symptoms;
4) determining sampling procedures by planning the testing method and by determining the number of samples to be screened:

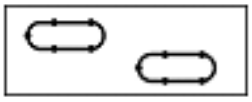
- if you are trying to detect pests or problems suspected to be **uniformly distributed** or whose distribution pattern is unknown, spread out the sampling points uniformly:



- if your aim is to detect pests or problems suspected of arising **from external rows**, spread out the sampling points uniformly around the field:



- if you are looking for pests or problems suspected of being located **in certain portions of the plot**, the sampling points must be concentrated in these sectors:



5) data recording allowing the observer to quantify the populations of pests present and to follow the progress and distribution of parasites during one single season and subsequent growing seasons (particularly with regard to the 'threshold of intervention').

4.4.1. Direct observation and counting

This method consists of selecting seedlings at random or a particular number of plants along a row of seeds and observing the presence of the pest or the disease on all parts of the plant. This method can be used early in the season and can be applied to the first stages of vegetative development. It has the advantage of not being destructive as no sample of plant material needs to be taken. However, it can only be applied when there is little wind (under 12 km/h). It also requires a good knowledge of the insect system, and the symptoms of the diseases.

In an open environment or one with little plant cover, direct counting can be carried out. You may need to use a magnifying glass for close observation. In addition, this method can be used for counting birds' nests or breeding pairs.

4.4.2. Trapping and capturing techniques

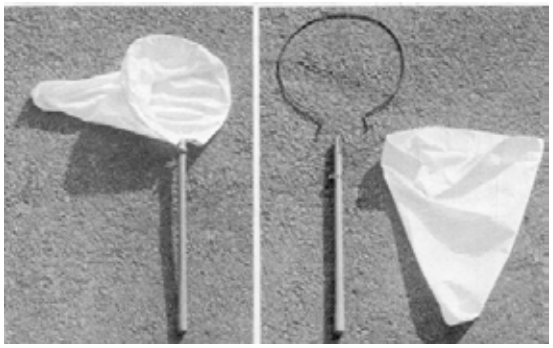
❑ **Ground cover**

This method of sampling consists of making the pests fall onto a **piece of light-coloured fabric** measuring approximately 20 cm pegged out **on the ground** at the foot of the plant between two adjacent rows of seeds in order to collect the insects and count them. Obviously, this method is not applicable for insects that fly away rapidly and at the slightest contact (e.g. crickets). It is well suited for the Coleoptera, which often let themselves drop when they sense danger and for the caterpillars of Lepidoptera.

Once the pests have been collected, the species can either be identified and counted in the actual field, or be transferred in a suitable container (glass bottle, small plastic tubes…) and then taken to the laboratory to be analysed at a later point. This method is suitable for pests with slow movements but is limited by the size of the seedlings. If they

are too small or in senescence, the technique becomes unsuitable. In addition, shaking the seedling can cause leaves to fall outside the perimeter delimited by the piece of fabric and it becomes difficult to count them correctly.

❑ The sweep net



For over a century, this method has been the most widespread for capturing Arthropods harmful to crops. This can be explained by the fact that, in spite of difficulties with standardization, there is no other method capable of capturing so many insects per head and per hour without increasing the cost of the equipment and damaging the crop.

Sweep net

This net consists of three basic elements: the actual **conical net**, the ring which keeps the net open as well as the handle, joined to the ring, made out of aluminium or wood.

Sampling can be carried out **all along a row of plants** by holding the net by the handle and passing it through the foliage. It is also possible to sample the adjacent row as well, by using a zigzag movement. In spite of the fact that this method is very suitable for trapping Arthropods, its results are often variable because of environmental factors such as temperature (which influences the metabolism of insects and therefore their ability to escape), humidity, which has an effect on the microclimate and the location of insects, the position of the sun (the shadow cast by the operator may chase away the insects), the size of the seedlings (which are fragile when small) and the density of the vegetation, which may have a degree of mechanical resistance to the net. When the foliage is wet after rainfall, the net becomes difficult to use.

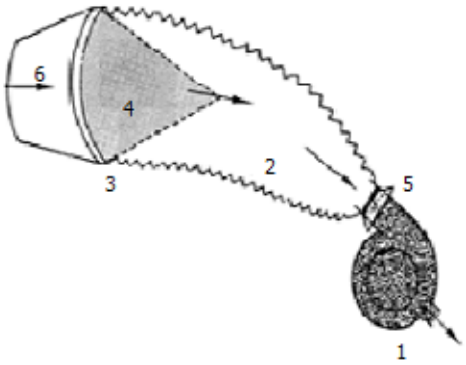
In order to convert the number of insects trapped into absolute estimates of the population, regression methods are used by comparing the population estimates based on insects captured with population densities determined on the basis of an absolute method of sampling such as cage fumigation or collecting the entire plant.

❑ Succion nets

These function by **suction** as fixed or mobile traps for sampling pests within a crop. They have a draft tube (portable fan), a gasoline tank, a flexible air pipe, a collection bag, a small cone and a control.

The sample must be taken in the opposite direction to the direction of the wind. It is possible to take samples over a clearly determined length all along a row by holding the head of the cone horizontally with the rounded part of the net forming an angle of 45° with the row and the top part of the plant.

Diagram of a suction net:



Using a suction net

1: fan
2: flexible air tube
3: ring to hold cone
4: net made of tulle
5: filter protecting fan
6: cone adjusting the diameter of the net

This tool is useful for **small-sized pests** capable of being sucked up by the current of air and not frightened by the noise of the apparatus and the movement of the operator. This technique produces good results for flies, some small larvae of Lepidoptera, nymphs and adults of some Hemiptera.

Using this trapping method, the surface of the conical head corresponds to a zone of the field being sampled. The residual population may be determined by direct observation, but better calibration is produced by comparing the results with those of a more absolute method.

❑ Pheromone traps

In market garden crops, fruit and vegetable crops, the caterpillars of butterfly pests and other insects which are parasitic on crops can cause considerable damage. The pheromone trap is a useful tool for detecting insect pests, provides information about the extent of the attack and helps the grower to determine the right time to destroy them.

Pheromones are **chemical signals exchanged between the individuals of the same species** and influence their behaviour. For example, there are sexual pheromones which

attract male butterflies located a long distance away from female butterflies. The pheromone trap makes use of this phenomenon to attract insect pests.

The type of trap which gives the best results in practice is the 'Delta' trap. This trap consists of a sticky base and a top in hard-wearing, water-resistant material. The trap is hung from a hook placed in the middle of the top. The capsule, containing the pheromones, is located between the top and the sticky base. Males, attracted by the female pheromones, are trapped and remain fixed to the sticky base. By examining this base, the pests can be identified. Counting allows us to obtain an idea of the size of their population and their distribution. Once a certain number of males are trapped, control methods must be started. Pheromones are specific to each insect pest. How long a pheromone's activity lasts depends on its composition, the number of traps used, its concentration and the climate.

Sexual traps are another type of pheromone trap, which use capsules impregnated with a pheromone similar to the pheromone of the female of the pest sought. There are sexual traps for Lepidoptera, but also for other pests, such as certain Diptera.

There are two main categories of trap: **traps for detection** and **traps for extensive trapping**.

- *Traps for detection* (or 'monitoring') are used to **indicate when a pest is beginning to fly**. Hence the user is able to use a sustainable approach when applying chemical or biological treatments (e.g. for the introduction of trichogram wasps). They are mainly sticky traps, so the males attracted by the synthetic pheromone become trapped. This type of trap may be used for numerous pests in tree crops, field crops, market garden and ornamental crops, viticulture, and so on

- *Traps for extensive trapping*, consisting of a funnel and a receptacle which holds the butterflies, are used to **capture large quantities** of Lepidoptera. Using a synthetic attractant, the aim is to capture and destroy a large number of insect pests on crops. This method is specific and environmentally-friendly. This method of control via extensive trapping is able to control pest populations in the medium term, but is not effective against all species. It is of particular use against Lepidoptera pests.

❑ **Sticky traps**

- Delta traps

The delta trap, generally made from recyclable plastic or cardboard, is impregnated with sexual pheromones but also with glue which traps the insects. This trap has a small entrance to prevent insects from escaping.

- Wing traps

The wing trap is also made of paper resistant to bad weather, with sticky internal surfaces, wide openings for increased diffusion of the pheromone in the surrounding environment and bait with pheromones inoffensive to other insects. However, the efficiency of these traps is poor.

- Cone traps

This trap uses synthetic pheromones fixed to the base of a cone net as bait. This cone is placed at ground level in high grass and the insects which are trapped in it accumulate in a reservoir on top. These traps are the most effective on the market, although the trapping period is 4 to 8 days longer than that for light traps. They are almost 4 times as effective if placed in the middle of the vegetation and not above it. They are also effective outside the plot, during the pest's first cycle (Lepidoptera).

❑ **Water pan traps**

A capsule containing pheromones is fixed to a string above a container holding a "wetting agent". This liquid, consisting of soapy water, reduces the water repelling nature of the cuticle of insects, which can no longer remain on the surface and hence sink more easily to the bottom of the container. The liquid in the container must be changed regularly (every week) for an optimum yield. They are as effective as light traps, but unfortunately they are very dependent on atmospheric conditions, either evaporating in dry conditions or becoming diluted in rainy conditions.

❑ **Other traps**

- **Black light traps** are especially effective for Lepidoptera and other nocturnal insects. The light produced by a 15 W bulb attracts butterflies or other insects which fly into the metal plates impregnated with soap. The insects then slide into a container full of soapy water and remain trapped there. These traps are among the most effective where there are high densities of insects. However, they do not contain pheromones, so are not very selective. They actually attract not only the female Lepidoptera of a given species but also other species, or even other insects. These traps can therefore make counting the insects difficult if similar species are mixed together.

- The most effective trap is still **the coloured bowl** (**yellow**) **full of soapy water** (**water traps**) which collect the insects attracted by the colour. Water has an attractive effect in the sense that the insects move towards places where humidity

indicates the presence of water. The reflections from solar and atmospheric light on its surface also have an effect of attraction and finally this hides the walls of the dish to an extent and the insects focus on the water. The insects are attracted over a distance of 30 to 40 cm. These traps have numerous advantages such as their simplicity and low cost, the ease of collecting the insects (the contents of the dish are poured into a funnel with a removable plastic tube at the end. The contents of this are then collected in a container and alcohol is squirted in). This keeps the insects in good condition (apart from butterflies). Finally, they do not require any source of energy. The specific nature of the captures should be noted, as the insects are usually attracted by specific wavelengths.

- The **Malaise trap** resembles a canvas tent in which flying insects “are lost”; passively directed to the higher end of the "roof" before being collected in a container fixed to this end.

- The **emergence trap** is able to collect populations of ground Arthropods. It can be used in a *dry extraction* form or a *wet extraction* form:
  - **Dry extractors** (Berlèse apparatus; Tullgren apparatus; Tullgren apparatus combined with repellents such as naphthalene) use a source of heat and are suitable for micro and macro-arthropods.
  - **Wet extractors** (Barmann, Seinhorst or Milne apparatus) often consist of a sieve containing the sample of earth onto which *water* is poured, with the entire mixture then being heated by a lamp placed over it. The oxygen content drops and the animals fall down a tube to escape from the heat, reaching a container of cold water where they are collected. These wet extractors are suitable for samples of nematodes.

  There are also mechanical methods of **extraction by directly examining samples of earth** with or without colorant (nematodes), by means of the **direct examination of sections of soil**, by means of extraction by **dry sifting** (Coleoptera), by means of extraction by **floating** (nematodes, acarids, molluscs), by **wet sifting and flotation** (Ladell, Aguilar, Bernard and Bessard methods, Salt and Hollick method), by means of **centrifuging and flotation**, by **sedimentation**, by **elutriation**, and by **maceration of the substrate**.

4.4.3. Absolute sampling methods

Accurate methods of estimating population densities are needed to produce management programmes for pest populations. The methods described above depend on environmental and human conditions and other biological factors. The validity of the data collected using these techniques can only be judged on the basis of their efficacy when these are compared to a more reliable and less costly sampling method. The two methods described below are based on isolating a population over a known surface area.

The first method is **cage fumigation** (cage made from wood, plastic or lightweight metal). The cage must also have a very small opening at the top in order to allow the application of the fumigant as well as a collection plate at the bottom. An aerosol pack containing 20% of a pyrethrinoid makes an excellent fumigant. 5 to 8 seconds of spraying are often

sufficient to have a “knock down” effect on Arthropods inside the cage. Without removing the cage, the operator inserts an arm through the injection cylinder and energetically shakes the plant. The cage is then removed and the insects are collected at the base.

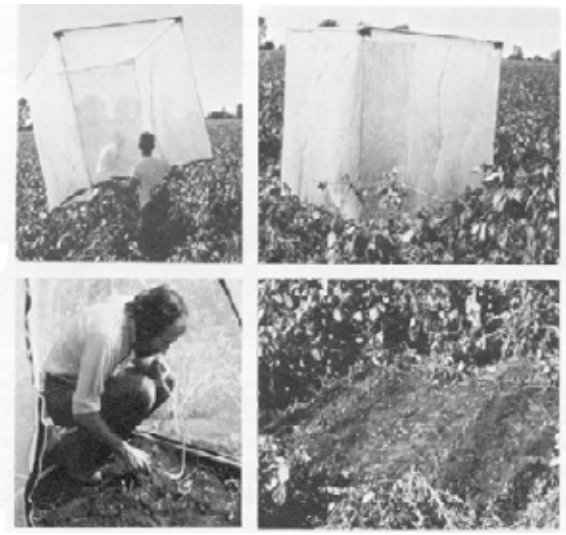
Sampling by fumigation (A: Choice of plant, B: Sample)

The second method consists of **collecting the whole plant** using a sampling cage measuring 1.8 x 1.8 x 1.8 meters, made of net and mounted on a cubic support. An opening which can be closed is made on one of the sides of the cage. This allows access to the inside of the cage. The cage is placed over the sampling location by two operators one of whom goes into the cage with an aspirator, labels and plastic bags. The aspirator is used to suck out the insects from plants, which are then pulled out and placed in bags provided for this purpose. The plant debris (leaves, branches) are also collected and placed in separate bags. The cage is left in place for 1 to 2 hours in order to collect the individuals that have fallen into holes or have been enveloped in dust when moving towards the edges of the cage. The methods of dry extraction allow the insects to be “removed” from the plant debris and the soil.

Using a method of statistical regression, in the form of $y = \beta x + \alpha$ is used, with y corresponding to the number obtained using the sampling method employed and x the number obtained using the absolute sampling method (fumigation or collection of plants), the efficacy of the sampling method selected is tested.

Illustration of the sampling method for the whole plant (sampling cage):

1: Transporting the cage to the field
2: Putting the cage in place
3: Collecting the insects that have fallen to the ground after sampling and bagging up the plants
4: Removing the cage and sampling surface



4.5. Methods of observing fungi and bacteria

4.5.1. Methods of observing symptoms

Accurate observation of symptoms and their development in time and space constitutes the first stage of the diagnosis. The symptoms are sometimes sufficiently defined and specific to allow the cause of a disease to be correctly identified without requiring other analyses: this is the case with certain traditional afflictions such as rust, mildew and smut.

However, more often than not, the situations encountered are complex: different agents may induce similar symptoms while, on the other hand, the same agent may produce symptoms which vary according to the situation. In addition, the most visible symptoms do not necessarily appear at the primary site of infection; for example, certain pathogenic agents responsible for necrosis of the radicular system or of vascular tissues (**primary symptoms** or **causal symptoms**) cause secondary withering or shrivelling of the aerial parts (**secondary symptoms** or **consequential symptoms**).

The period when symptoms appear, as well as the **climatic circumstances** which preceded their appearance, is extremely important when diagnosing a disease caused by a fungus or bacteria.

The **previous cultivation** as well as the different **operations carried out within the crop** may interfere with the initiation and development of symptoms; mineral fertilizers (doses and dates of application), plant health treatments (doses, commercial names, equipment and spreading techniques), work on the soil, the date of sowing or planting and the origin of batches of seeds or organs of propagation will be taken into particular consideration.

The history of the field may reveal circumstances which favour the appearance of symptoms, even after several years. Likewise, demarcation between symptoms may correspond, after several years, to the boundaries of plots with a different history. Spatial distribution may provide elements which are useful in the diagnosis: valley bottoms and sides of hills with a Northern exposure are locations which are particularly favourable to damage by fungi developing in rather more humid and cold conditions. Dips are often areas where symptoms of root asphyxia are seen.

The way in which diseased plants are distributed in the crop is also able to shed light on the way in which the causes of the infection are transmitted or on their transmission. Distribution in lines parallel to the seeds reflects human origin (compaction of the soil associated with the passage of machines, overdoses of manure or plant health products, linear distribution of an inoculum by tools). Diseased plants in an area at the entrance of a field may correspond to deposits from bags of manure (scabies caused by *Streptomyces scabies* in areas where calcium-containing fertilizer is stored); diseased plants distributed in small groups forming spots distributed at random in the field may reveal that the virus has been transmitted by aphids. On the other hand, a disease that appears year after year, in the same place and whose affected surface area is mainly increasing in the

direction in which the soil is worked, suggests a microbial origin or transmission of the virus by nematodes or by fungi.

At this stage in the diagnosis, it is important to **pick up on every clue** that will make it possible to determine the biotic or abiotic nature of the problem, by taking samples. When the cause of the disease cannot be established on-site, **samples need to be taken for subsequent analyses**.

This sampling must be carried out with the greatest of care, as its quality will determine the success of the later stages (observations under the microscope, isolation, etc.). It is always preferable to **sample entire plants** (including roots), rather than limiting the sample to the parts which seem damaged in order to identify the causal symptoms. It is also a good idea to take samples at various stages of progress of the disease, particularly in plants showing early symptoms (with a view to isolating the pathogenic agent and of observing its fruiting bodies) or showing an advanced stage of the infection (presence of the parasite's survival structure).

4.5.2. Methods of diagnosis in the laboratory

Various laboratory methods are used to make the diagnosis. They are the reserve of specialists and of well-equipped and, if possible, certified laboratories.

The laboratory techniques can be split into **three categories** depending on their aim:

- detecting infectious parts of the pathogenic agent (**biological methods**);
- revealing immunogenic molecules synthesized by the pathogenic agent (**immunological methods**);
- detecting sequences of nucleic acids that are specific to the genome of the pathogenic agent (**molecular methods**).

❑ **Biological methods**

A simple close examination of the surface of the samples of diseased plants using a **binocular magnifying glass**, or of a sample under the **microscope**, is sometimes sufficient to reveal carpophores of fungi or bacterial exudates whose presence may be grounds for diagnosing a parasitic disease.

Practical example: the 'exudates method' to confirm the presence of *Ralstonia solanacearum* (brown rot).

This method is used for certifying potato seedlings.

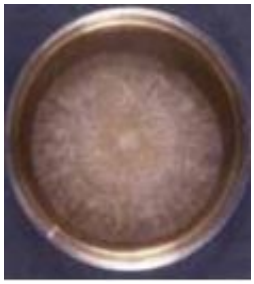
Ralstonia solanacearum is a soil bacterium, a Gram-negative plant pathogen, responsible for brown rot. Present on every continent, particularly in tropical and subtropical regions, the bacterium is stored in the soil where it can survive for several years. It penetrates through the roots and propagates through the vascular system; it is spread by irrigation water (surface water) or by the seedlings. It colonizes the xylem, causing bacterial rot or vascular bacteriosis in numerous host plants from the *Solanaceae* family (tomato, nightshade, pepper, aubergine, tobacco, etc.) and other plants as well.

Method of detection (extract from: *Draft of the plan to control the certification of potato seedlings, CDE - Lux Development – AIDCO, 2009)*:

Pull up the plant and check whether:

- The main stem and/or the roots are being attacked by an insect.
- The stems are rotting around the neck (Erwinia).
- The main stem is giving off an exudate:
  - Equipment: transparent glass + knife + bottle of clear water
  - Method: cut off the main stem 5 cm above the neck and soak it in a glass of water. Wait 1 to 3 minutes to check for the presence of white filaments coming out of the vascular tissue.

Result:
If filaments are observed, the plant is definitely suffering from *Ralstonia solanacearum*, which means that the soil, tubercles and nearby plants must be removed.



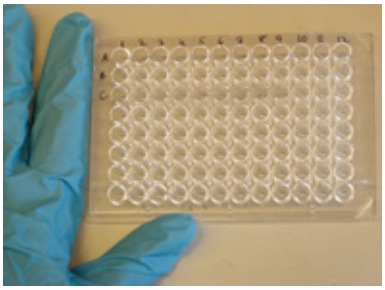
In more complex cases, a procedure will be used to **isolate the agent**; the different stages of this work involve: (1) choosing a plant sample; (2) disinfecting its surface, depositing it in a nutritional environment and (3) observing the growth of the uncontaminated culture.

The final identification can extend as far as inoculation of the agent which has been isolated. This method only applies to the pathogens capable of multiplying on the medium in vitro (fungi, bacteria).

Biological methods of diagnosing **obligate parasites** (viruses, phytoplasma etc.) are based on a series of operations: descriptions of the symptoms observed, **transmission of the infectious agent to host plants** and symptoms, determination of the range of host plants and the symptoms they express, observation under the microscope (possibly electronic), extraction and purification (in the case of viruses and viroids).

❑ Immunological or serological methods

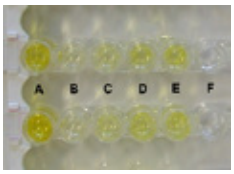
Numerous molecules of a pathogenic agent may behave like antigens by causing, in the lymphatic tissues of warm-blooded animals, the formation of antibodies with which they react specifically. Several serological techniques make use of this property; they use both polyclonal antibodies, and monoclonal antibodies.



Enzymatic marking of these antibodies has allowed the development of protocols capable of detecting phytopathogenic agents and quantifying them (**ELISA test**).

The ELISA (acronym for *Enzyme Linked Immuno-Sorbent Assay*) test is an immunological test intended to detect and/or assay a protein in a biological liquid.

The main advantages of immuno-enzymatic tests are their **sensitivity** and their **ease of use**. However, it may be difficult to obtain antibodies in the case of diseases with an ill-defined etiology, or disorders whose agent cannot be cultivated in vitro or purified easily.

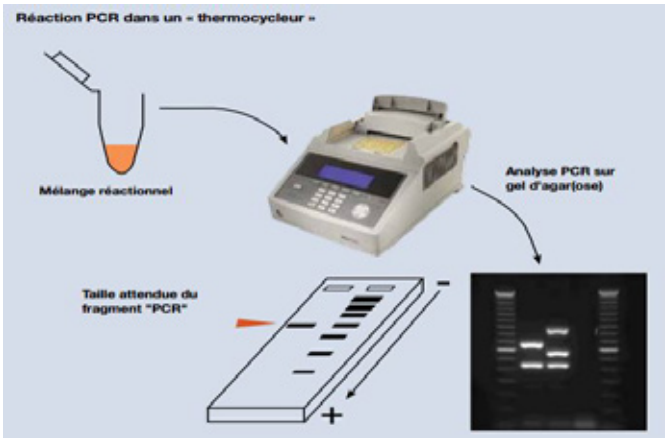


❑ Molecular methods

Serological methods cannot be used to diagnose diseases caused by viroids. In this case, diagnostic techniques are used based on **the analysis of sequences of nucleic acids** from infected plants using electrophoresis in polyacrylamide gel or on the characterization of nucleic acids by molecular hybridation.

Recourse to **molecular amplification**, via chain polymerization (**PCR** - *Polymerase Chain Reaction*), has made it possible to push back **the boundaries of sensitivity** of diagnostic techniques based on the detection of specific sequences of nucleic acids. The aim of the technique is to make a large number of copies of a given segment of DNA (e.g.: amplifying a specific region of a nucleic acid of the virus to be detected, in order to make the virus 'visible'). In order to make this possible, a series of reactions allowing the replication of a matrix of double-stranded DNA is repeated in a loop. In the course of the PCR (*polymer chain reaction*), the products obtained at the end of each cycle act as a matrix for the next cycle, so the amplification is exponential.

This amplification produces a **band on a gel** (see figure) that is specific, on account of its size, to the virus we are trying to reveal. If this technique is properly developed, it is both very sensitive (amplification possible as soon as there are a few cells infected with the virus alone) and very specific. The PCR reaction is extremely rapid and only lasts a few hours (2 to 3 hours for a PCR involving 30 cycles).



Reading results on the polyacrylamide gel

4.6. Detection of quarantine organisms (sampling) and plant health certificates

Protecting crops against their enemies is a **question of general interest**, which requires an **organization** capable of **preventing the introduction** of a plant pathogen into a given country or area and of issuing the certificates required to market plant products.

In the first case, **the crops in unaffected countries or regions are the priority** of the regulations. In the second case, the main aim of the regulations is to **protect the product being marketed and its user**. The merchandise may not constitute a risk to plant health as such, but it may be a carrier of harmful organisms.

Since March 2005, new European regulations and new obligations imposed on **wood packaging** have come into force.[1] The Directive aims to bring European legislation in line with the provisions of the "International Regulation for phytosanitary measures - ISPM N° 15" of the FAO relating to the "Directives on the Regulation of Wood Packaging Material in International Trade". From now on, any wood packaging material originating in a third country used in the export of foodstuffs to Europe must be the subject of plant health certification. The targeted products are mainly wood packaging material in the form of bins, boxes, crates, as well as pallets, bin-pallets and other loading stations. The third-party countries which carry out the export are therefore obliged to carry out a plant health examination of the wood products they use and to provide proof that the wood has been stripped, has undergone an appropriate thermal treatment at 56 °C, or appropriate fumigation, or even chemical impregnation under pressure.

4.6.1. International Plant Protection Convention (IPPC)

The International Plant Protection Convention (IPPC) was signed in 1951 under the aegis of the FAO. The convention was reviewed in 1997 in the wake of the Agreements of the Uruguay Cycle of the World Trade Organization (WTO), particularly the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). The convention is the result of international collaboration on plant protection and the prevention of the dissemination of agents harmful to plants (animals, viruses, prokaryotes, fungi, weeds). It reaffirms the need for plant health measures which are technically justified, transparent and compliant with the SPS Agreement and it supplies a framework which guarantees that the plant health regulations put in place have a scientific basis justifying their application and that they do not constitute a hidden restriction on international trade.

One of the most important measures as far as the IPPC is concerned consists of drawing up the inventory of harmful organisms which are particularly dangerous, whose

[1] Directive 2004/102/EC of 5 October 2004, amending Annexes II, III, IV and V of Council Directive 2000/29/EC on "protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community".

introduction to the Community must be prohibited, and harmful organisms whose introduction through certain plants or plant products must also be prohibited.

4.6.2. Risk evaluation procedures

Any plant health regulation must be based on a **risk evaluation** in accordance with a procedure which the FAO has codified (**PRA procedure**). The 'Pest Risk Analysis' is a process consisting of **evaluating biological evidence** or other scientific or economic data to determine whether a harmful organism should be regulated, and the severity of any plant health measures to be taken against it.

This procedure concerns harmful agents which meet the definition of a quarantine organism. According to the IPPC definition, a quarantine organism is 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.

The risk evaluation procedure will take into consideration criteria of a geographical, biological and economic nature into consideration such as the probability of establishment of the pathogen, its potential spread and the economic consequences of its introduction in a geographical region in which it is absent. Once the level of risk has been evaluated, all the means likely to reduce this risk to an acceptable level are envisaged. The principle of the 'minimum impact' recommended by the IPPC is to adopt quarantine measures whose restricting nature is proportional to the level of risk.

One of the essential requirements of a risk evaluation is to be able to have available accurate and reliable information about the geographical distribution of the agent under consideration. In this respect, the FAO, the RPPO (Regional Plant Protection Organisations) and various international organizations (CAB, EU etc.) publish documents that make it possible to monitor the emergence of pathogenic agents and their distribution world-wide.

4.6.3. Monitoring quarantine organisms

Inspecting consignments is an essential element of managing plant health risks, and it is the plant health procedure most frequently used to establish whether or not harmful organisms are present and/or their compliance with the plant health requirements of the destination market.

❑ **Basis for sampling**

Each batch must be checked. A whole dispatch cannot always be inspected, which is why the phytosanitary inspection generally involves samples from the dispatched lots.

A '**dispatch**' may comprise one or several batches of products. When it involves more than one batch, the inspection aimed at establishing compliance will possibly give rise to several different visual examinations, which involves **sampling the batches separately**. In this case, the samples relating to each batch must be isolated and identified so that the batch concerned can be clearly identified if a subsequent inspection or analysis shows that it does not comply with plant health requirements.

Sampling within a batch begins with **identification of the most suitable sampling unit** (e.g.: *n* fruits, unit of weight, bag, carton) depending on the product.[2] As a rule, fruits or vegetables are inspected during sorting in the station or during packaging.

When compiling the sampling plan, the level of acceptance for a quarantine organism must be fixed at **zero**, and the **calculation of the number of samples** must be carried out on this basis.

In order to calculate the number of samples to be examined (**n**) out of a population (= one batch) of fruit/vegetables (**N**), 2 possibilities must be taken into consideration:

- Sampling of **small batches**: the size of the sample (n) > 5% of the size of the batch (N).
  In this case, when a unit from the batch is sampled, **the probability** that the next unit sampled will be infested changes. Sampling, without any replacement in a small batch, is based on a hypergeometric distribution.
- Sampling of **large batches**: the size of the sample (n) < 5% of the size of the batch (N).
  In this case, for large size batches which have been adequately mixed together, sampling is based on a binomial distribution or a poison distribution.

Please note!

Even if no individual (egg, larva or adult) is detected in the sample examined, the probability that an organism is present, even at a very low level, remains. The threshold of monitoring in principle is not in itself a guarantee of plant health compliance.

Simple random sampling is used. In practice, the **operator uses Tables from Standard ISPM 31** – *Methodologies for sampling of consignments* (FAO, IPPC 2008).

❑ Calculating the number of units to examine in small batches

In **Standard ISPM 31** – *Methodologies for sampling consignments* (FAO, IPPC 2008), the operator will find 4 tables[3] indicating the minimum number of samples to be examined according to the number of fruits/vegetables in a batch and the confidence level selected (80%, 90%, 95% or 99%). As a general rule, a confidence level of 95% is deemed to be sufficient.

The size of the sample is determined from the level of detection and the degree of efficacy.

Minimum sizes of the sample for a 95 per cent confidence level, according to the size of the batch, with the level of acceptance being 0:

[2] Distribution not approved.

[3] The tables (ISPM 31) are available on the IPPC site: www.acfs.go.th/sps/downloads/ISPM_31.pdf.

Number of units in the batch	P = 95% (confidence level) % level of detection × efficacy of detection				
	5	**2**	**1**	**0,5**	**0.1**
25	24*	-	-	-	-
50	39*	48	-	-	-
100	45	78	95	-	-
200	51	105	155	190	-
300	54	117	189	285*	-
400	55	124	211	311	-
500	56	129	225	388*	-
600	56	132	235	379	-
700	57	134	243	442*	-
800	57	136	249	421	-
900	57	137	254	474*	-
1,000	57	138	258	450	950
2,000	58	143	277	517	1,553
3,000	58	145	284	542	1,895
4,000	58	146	288	556	2,108
5,000	59	147	290	564	2,253
6,000	59	147	291	569	2,358
7,000	59	147	292	573	2,437
8,000	59	147	293	576	2,498
9,000	59	148	294	579	2,548
10,000	59	148	294	581	2,588
20,000	59	148	296	589	2,781
30,000	59	148	297	592	2,850
40,000	59	149	297	594	2,885
50,000	59	149	298	595	2,907
60,000	59	149	298	595	2,921
70,000	59	149	298	596	2,932
80,000	59	149	298	596	2,939
90,000	59	149	298	596	2,945
100,000	59	149	298	596	2,950
200,000 and over	59	149	298	597	2,972

Example of application:

For a batch of approximately 2,000 fruits, if we estimate that on average the percentage of infested fruits is 2%, 143 fruits must be sampled (approximately 7% of the fruits). The confidence level of 95% means that on average only 5% of infested fruits will not be detected.

❑ Calculating the number of units to examine in large batches

In **Standard ISPM 31** – *Methodologies for sampling of consignments* (FAO, IPPC 2008), the operator will find 2 tables (one according to the binomial law, the other according to the Poisson law) indicating the minimum number of samples (n) to be examined in the large batches depending on the confidence level chosen (95% or 99%). The size of the sample is determined from the level of detection and the % of efficacy.

Minimum sizes of the sample for 95 or 99 per cent levels of confidence, according to the values of efficacy, with the level of acceptance being 0:

n according to the binomial law					
% of efficacy	P = 95% (confidence level) % level of detection				
	5	2	1	0.5	0,1
100	59	149	299	598	2,995
99	60	150	302	604	3,025
95	62	157	314	630	3,152
90	66	165	332	665	3,328
85	69	175	351	704	3,523
80	74	186	373	748	3,744
75	79	199	398	798	3,993
50	119	299	598	1,197	5,990
25	239	598	1,197	2,396	11,982
10	598	1,497	2,995	5,990	29,956

n according to the binomial law					
% of 'efficacy	P = 99% (level of confidence) % level of detection				
	5	2	1	0.5	0.1
100	90	228	459	919	4,603
99	91	231	463	929	4,650
95	95	241	483	968	4,846
90	101	254	510	1,022	5,115
85	107	269	540	1,082	5,416
80	113	286	574	1,149	5,755
75	121	305	612	1,226	6,138
50	182	459	919	1,840	9,209
25	367	919	1,840	3,682	18,419
10	919	2,301	4,603	9,209	46,050

Minimum sizes of the sample for 95 or 99 per cent levels of confidence, according to the values of efficacy, with the level of acceptance being 0:

n according to the Poisson law					
% of efficacity	P = 95% (confidence level) % level of detection				
	5	2	1	0.5	0.1
100	60	150	300	600	2,996
99	61	152	303	606	3,026
95	64	158	316	631	3,154
90	67	167	333	666	3,329
85	71	177	353	705	3,525
80	75	188	375	749	3,745
75	80	200	400	799	3,995
50	120	300	600	1,199	5,992
25	240	600	1,199	2,397	11,983
10	600	1,498	2,996	5,992	29,958

n according to the Poisson law					
% of efficacity	P = 99% (confidence level) % level of detection				
	5	2	1	0.5	0.1
100	93	231	461	922	4 606
99	94	233	466	931	4 652
95	97	243	485	970	4 848
90	103	256	512	1,024	5,117
85	109	271	542	1,084	5,418
80	116	288	576	1,152	5,757
75	123	308	615	1,229	6,141
50	185	461	922	1,843	9,211
25	369	922	1,843	3,685	18,421
10	922	2,303	4,606	9,211	46,052

Example of application:

For a batch of approximately 400,000 fruits, if we want to be able to detect with 95% confidence an infestation of 1% of fruits with an efficacy of 80%, 353 to 375 fruits must be sampled, *i.e.* approximately 0.1% fruits to be examined. The 95% confidence level means that on average only 5% of infested fruits will not be detected.

4.6.4. Plant health measures implemented

❑ **Quarantine and eradication measures**

Plant health regulations may prohibit importation, submit their authorization to a prior plant health inspection or make disinfecting of the merchandise obligatory. Once the first source of a quarantine agent has been declared, we can try to prevent its spread by means of a regulation imposing the detection of the disease, the application of certain measures with a view to eradicating or limiting it, or sometimes even abandoning growing some sensitive species or varieties.

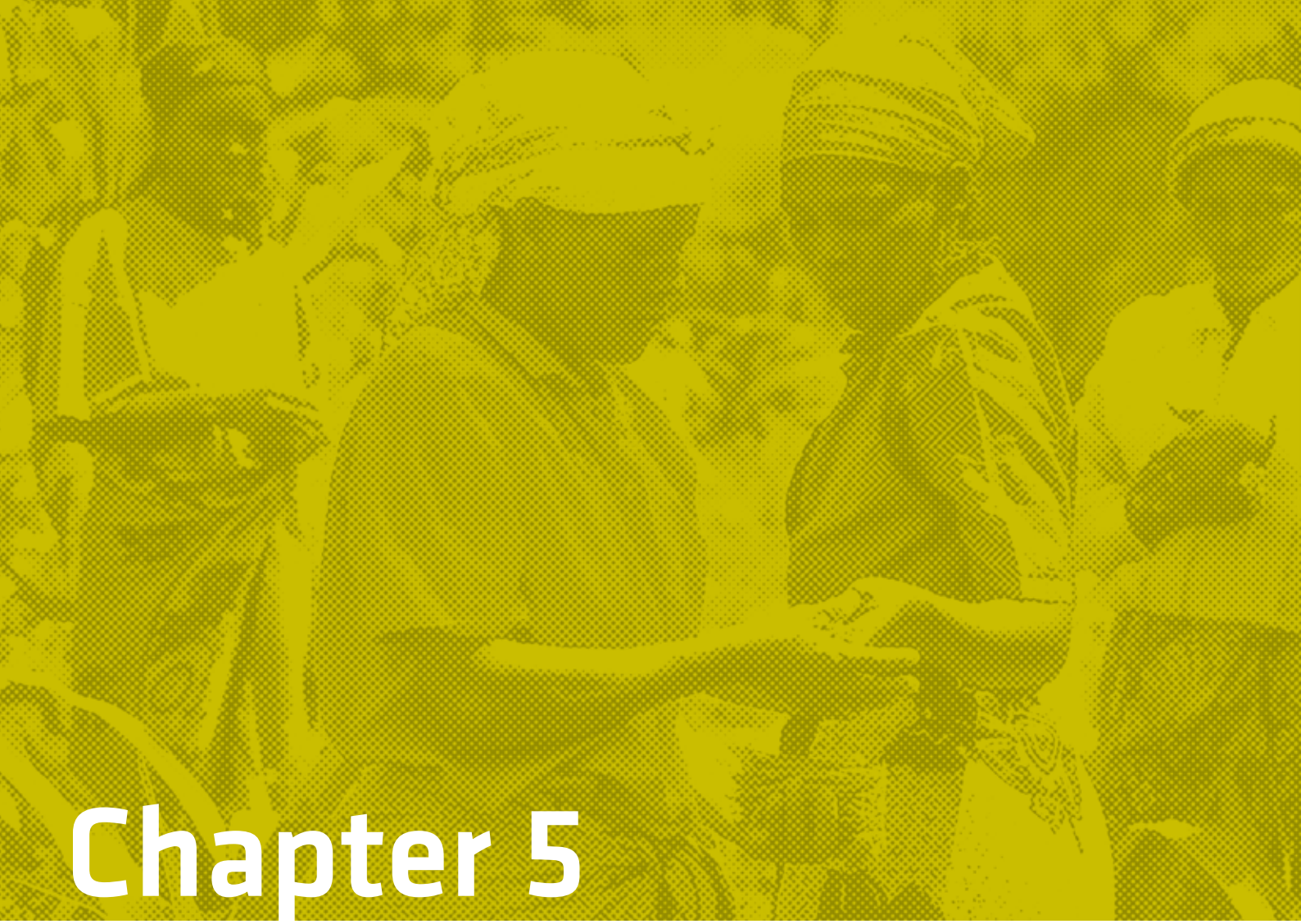
❑ **Certification**

The plant health certificates are **issued by a qualified authority** which must guarantee that the product is free from any disease covered by quarantine laws. Issuing plant health certificates is therefore entrusted to technically qualified operators duly authorized by the national organization for the protection of plants to act on its behalf and under its control, possessing the necessary knowledge and information so that the importing authorities can accept the plant health certificates of other States as reliable documents. For Europe, the Plant Health Certificate must be compiled according to the Model shown in Annex VII of **Directive 2000/29/EC**.

For the so-called ‘quality’ organisms, certification guarantees the user a product suitable for the use for which it was purchased.

❑ **Cost/benefit of regulatory measures**

A preventive plant health regulation will only be adopted after having compared the cost of applying these administrative measures and whichever of the means of control which must be implemented if the disease has been introduced to the country.



Chapter 5

Export certification system

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Requirements 120

5.1. Introduction

This chapter is based on the text of ISPM No. 7.

This standard was endorsed by the 29th Session of the FAO Conference in November 1997.

5.1.1. Introduction scope

This standard describes the components of a national system for the issuance of phytosanitary certificates.

5.1.2. References

Glossary of phytosanitary terms, 1997, ISPM No. 5, FAO, Rome.
International Plant Protection Convention, 1992, FAO, Rome

5.1.3. Definitions

Definitions of phytosanitary terms used in the present standard can be found in ISPM No. 5 (Glossary of phytosanitary terms).

5.1.4. Outline of requirements

The International Plant Protection Convention (IPPC) requires its contracting parties to make arrangements to issue phytosanitary certificates certifying compliance with the phytosanitary regulations of other contracting parties. This standard describes an export certification system to produce valid and credible phytosanitary certificates. Exported consignments certified under these systems should meet the current phytosanitary requirements of the importing country. The basic elements of the phytosanitary certification process include:

- ascertaining the relevant phytosanitary requirements of the importing country (including import permits if required);
- verifying that the consignment conforms to those requirements at the time of certification;
- issuing a phytosanitary certificate.

The requirements for a certification system to fulfil these functions comprise the following:

- legal authority;
- management responsibility, including resources, documentation, communication and review mechanism.

5.2. Requirements

The framework for a certification system includes the following components.

5.2.1. Legal authority

The National Plant Protection Organization (NPPO) should have the sole authority by legislative or administrative means for control and issuance of phytosanitary certificates. In using this authority, the NPPO should:

- bear the legal authority for its actions;
- implement safeguards against potential problems such as conflicts of interest and fraudulent use of certificates.

The NPPO may have the authority to prevent the export of consignments which do not meet an importing country's requirements.

5.2.2. Management responsibility

The NPPO should:

- have a management system that ensures that all requirements, including certification specifications, legislative requirements and administrative requirements are satisfied;
- identify a person or office responsible for the export certification system;
- identify the duties and lines of communication of all personnel with certification-related responsibilities;
- ensure that adequate personnel and resources are available to undertake the following functions:
    - maintenance of information on importing country phytosanitary requirements as needed;
    - production of operational instructions to ensure that importing country phytosanitary requirements are satisfied;
    - inspection and testing of consignments and associated conveyances;
    - identification of organisms found during inspection of consignments;
    - verification of the authenticity and integrity of phytosanitary procedures;
    - completion and issue of phytosanitary certificates;
    - document storage and retrieval;
    - training;
    - dissemination of certification-related information;
    - review regularly the effectiveness of its export certification system;
    - development of bilateral protocols if necessary.

5.2.3. Resources

❑ **Staff**

The NPPO should have personnel with a level of expertise appropriate for the duties and responsibilities of the positions being occupied. NPPOs should have or have access to personnel with training and experience in:

- performing inspections of plants, plant products and other regulated articles for purposes related to the issuance of phytosanitary certificates;
- identification of plants and plant products;
- detection and identification of pests - performing or supervising phytosanitary treatments required for the certification in question;
- survey, monitoring and control activities related to phytosanitary certification – constructing appropriate certification systems and formulating instructions from importing country phytosanitary requirements;
- auditing of accredited personnel and certification systems, where appropriate.

Except for the issuance of phytosanitary certificates, non-governmental personnel may be accredited by the NPPO to carry out specified certification functions. To be accredited, such personnel should be qualified and skilled, and responsible to the NPPO. To ensure independence in their exercise of official functions, they should be subject to restrictions equivalent to those for government officials and have no financial interest in the outcome.

❑ **Information on importing country phytosanitary requirements**

The NPPO should, to the extent possible, maintain official current information concerning the import requirements of its trading partners. It may be useful for the exporter to obtain information on the current import requirements for the country of destination and supply it to the NPPO.

❑ Technical information

The NPPO should provide the personnel involved in phytosanitary certification with adequate technical information concerning quarantine pests, and to the extent possible, non-quarantine pests, for the importing countries including:

- their presence and distribution within the exporting country;
- the biology, surveillance, detection and identification of the pests;
- pest management, where appropriate.

❑ **Equipment**

The NPPO should ensure that adequate equipment and facilities are available to carry out inspection, testing, consignment verification and phytosanitary certification procedures.

5.2.4. Documentation

❑ **Phytosanitary certificates**

The model phytosanitary certificates as described in the Annex of the IPPC should be used. The phytosanitary certificate should contain sufficient information to clearly identify the consignment to which it relates. The phytosanitary certificate should not carry other information, of a non-phytosanitary nature. The validity of phytosanitary certificates should not be indefinite but limited in duration (prior to export), to the extent the NPPOs deem appropriate, to ensure phytosanitary and physical integrity. Appropriate disclaimers related to legal liability may be included on the phytosanitary certificate issued.

❑ **Phytosanitary certificate for re-export**

Before issuing a phytosanitary certificate for re-export of a consignment, the NPPO should first examine the original phytosanitary certificate issued by the country of origin and determine whether the requirements of the country of destination are more stringent, the same, or less stringent than those satisfied by the phytosanitary certificate. If the consignment is repacked, additional inspection should be carried out, whatever the stringency of the requirements. If, however, the consignment is not repacked, two cases arise. If the requirements are the same or less stringent, no additional inspection will be required. If the requirements are more stringent, additional inspection should be carried out. If the country of destination has special requirements (e.g. field inspection) that cannot be fulfilled by the country of re-export, no phytosanitary certificate for re-export can be issued unless this special item has been included or declared on the original phytosanitary certificate or if equivalent laboratory tests agreed by the country of destination can be done on samples. When regular re-export exists, or is started, suitable procedures for satisfying these special requirements may be agreed between the NPPOs of the countries of origin and re-export. If the country of re-export does not require a phytosanitary certificate for the commodity in question but the country of destination does, and the requirements can be fulfilled by visual inspections or laboratory testing of samples, the country of re-export may issue a normal phytosanitary certificate with the country of origin indicated in brackets.

❑ Procedures

The NPPO should maintain guidance documents, procedures and work instructions as appropriate covering every aspect of the certification system. Key elements include:

- instructions relating to phytosanitary certificates:
    - control over issuance (manual or electronic);
    - identification of issuing officers • inclusion of additional declarations;
    - completion of the treatment section of the certificate;
    - certified alterations;
    - completion of phytosanitary certificates;
    - signature and delivery of phytosanitary certificates;
- instructions relating to other components:
    - procedures for working with industry;
    - sampling, inspection and verification procedures;
    - security over official seals/marks;
    - consignment identification, traceability, and security;
    - record keeping.

❑ Records

In general, records should be kept concerning all activities mentioned in this standard. A copy of each phytosanitary certificate should be retained for purposes of validation and "trace back". For each consignment for which a phytosanitary certificate is issued, records should be kept as appropriate on:

- any inspection, testing, treatment or other verification which was conducted on a consignment basis;
- the names of the personnel who undertook these tasks - the date on which the activity was undertaken;
- the results obtained;
- any samples taken.

It may be useful to keep equivalent records for those non-conforming consignments for which phytosanitary certificates were not issued. The NPPO should be able to retrieve these records when required, over an appropriate period of time. The use of secure electronic storage and retrieval is recommended for standardized documentation of records.

❑ Consignment tracing

Consignments and their certification should be traceable as appropriate through all stages of production, handling and transport to the point of export. If the NPPO becomes aware after certification that an exported consignment may not have complied with the importing country's phytosanitary requirements, the importing country's NPPO should be so advised as soon as practicable.

5.2.5. Communication

❑ **Within the exporting country**

The NPPO should have procedures in place for timely communication to relevant personnel and to industry concerning changes in:

- importing country phytosanitary requirements;
- pest status and geographical distribution;
- operational procedures.

The NPPO may put in place, for non-conforming consignments, a procedure which enables rapid communication to all affected industry parties and certification personnel. This is in order to facilitate resolution of the problem and to prevent re-submission of the consignment unless approved corrective action has been undertaken.

❑ **Outside the exporting country**

The NPPO should:

- liaise with the nominated representatives of relevant NPPOs to discuss phytosanitary requirements;
- make available a contact point for importing country NPPOs to report cases of non-compliance;
- liaise with the relevant Regional Plant Protection Organizations and other international organizations in order to facilitate the harmonization of phytosanitary measures and the dissemination of technical and regulatory information.

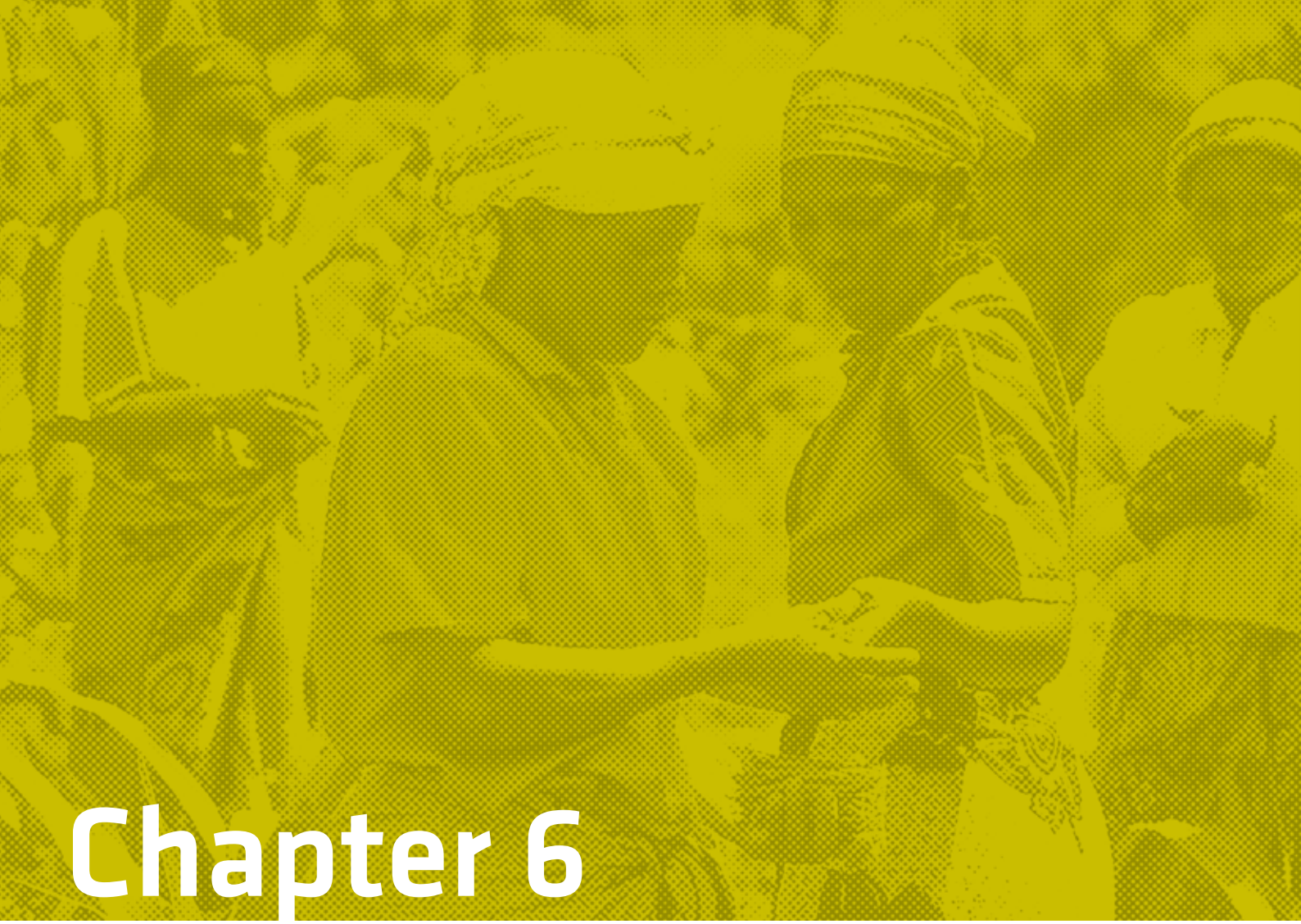
5.2.6. Review mechanism

❑ **System review**

The NPPO should periodically review the effectiveness of all aspects of its export certification system and implement changes to the system if required.

❑ **Incident review**

The NPPO should establish procedures for investigating reports from importing countries of non-conforming consignments covered by a phytosanitary certificate. If requested, a report of the outcome of the investigation should be supplied to the importing country.



Chapter 6

Guidelines for phytosanitary certificates

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Requirements for phytosanitary certificates 127
Appendix 135

6.1. Introduction

This chapter is based on the text of ISPM No. 12.

This standard was endorsed by the Interim Commission on Phytosanitary Measures in April 2001.

6.1.1. Introduction scope

This standard describes principles and guidelines for the preparation and issue of phytosanitary certificates and phytosanitary certificates for re-export.

6.1.2. References

Export certification system, 1997. ISPM No. 7, FAO, Rome.
Glossary of phytosanitary terms, 1999. ISPM No. 5, FAO, Rome.
New Revised Text of the International Plant Protection Convention, 1997. FAO, Rome.
Requirements for the establishment of pest free places of production and pest free production sites, 1999. ISPM No. 10, FAO, Rome.

6.1.3. Definitions

Definitions of phytosanitary terms used in the present standard can be found in ISPM No. 5 (Glossary of phytosanitary terms).

6.1.4. Outline of requirements

This standard describes principles and guidelines to assist National Plant Protection Organizations (NPPOs) with the preparation and issue of phytosanitary certificates and phytosanitary certificates for re-export. Model certificates are provided in the Annex of the International Plant Protection Convention (IPPC) adopted in 1997 and are appended to this standard for reference. Explanations are given on the various components of the model certificates indicating the information needed for their appropriate completion.

6.2. Requirements for phytosanitary certificates

6.2.1. General considerations

Article V.2a of the IPPC (1997) states that: *"Inspection and other related activities leading to issuance of phytosanitary certificates shall be carried out only by or under the authority of the official national plant protection organization. The issuance of phytosanitary certificates shall be carried out by public officers who are technically qualified and duly authorized by the official national plant protection organization to act on its behalf and under its control with such knowledge and information available to those officers that the authorities of importing contracting parties may accept the phytosanitary certificates with confidence as dependable documents"* (*see* also ISPM No. 7: Export certification system).

Article V.3 states: *"Each contracting party undertakes not to require consignments of plants or plant products or other regulated articles imported into its territories to be accompanied by phytosanitary certificates inconsistent with the models set out in the Annex to this Convention. Any requirements for additional declarations shall be limited to those technically justified".*

As clarified at the time of the adoption of the IPPC (1997), it is understood that 'public officers who are technically qualified and duly authorized by the national plant protection organization' include officers from the national plant protection organization. 'Public' in this context means employed by a level of government, not by a private company. 'Include officers from the national plant protection organization' means that the officer may be directly employed by the NPPO, but does not have to be directly employed by the NPPO.

❑ **Purpose of phytosanitary certificates**

Phytosanitary certificates are issued to indicate that consignments of plants, plant products or other regulated articles meet specified phytosanitary import requirements and are in conformity with the certifying statement of the appropriate model certificate. Phytosanitary certificates should only be issued for this purpose. Model certificates provide a standard wording and format that should be followed for the preparation of official phytosanitary certificates. This is necessary to ensure the validity of the documents, that they are easily recognized, and that essential information is reported. Importing countries should only require phytosanitary certificates for regulated articles. These include commodities such as plants, bulbs and tubers, or seeds for propagation, fruits and vegetables, cut flowers and branches, grain, and growing medium. Phytosanitary certificates may also be used for certain plant products that have been processed where such products, by their nature or that of their processing, have a potential for introducing regulated pests (e.g. wood, cotton). A phytosanitary certificate may also be required for other regulated articles where phytosanitary measures are technically justified (e.g. empty containers, vehicles, and organisms). Importing countries should not require phytosanitary certificates for plant products that have been processed in such a way that they have no potential for introducing regulated pests, or for other

articles that do not require phytosanitary measures. NPPOs should agree bilaterally when there are differences between the views of the importing country and exporting country regarding the justification for requiring a phytosanitary certificate. Changes regarding the requirement for a phytosanitary certificate should respect the principles of transparency and non-discrimination.

❑ Mode of issue

The phytosanitary certificate is an original document, or under specific circumstances is a certified copy issued by the NPPO, that accompanies the consignment and is presented to the relevant officials upon arrival in the importing country. Alternatively, electronic certification may be used provided that:

- the mode of issue and security is acceptable by the importing countries;
- the information provided is consistent with the appropriate model(s);
- the intent of certification under the IPPC is realized;
- the identity of the issuing authority can be adequately established.

❑ Attachment

Official attachments to the phytosanitary certificate should be limited to those instances where the information required to complete the certificate exceeds the available space on the certificate (*see* also point 2). Any attachments containing phytosanitary information should bear the phytosanitary certificate number, and should be dated, signed and stamped the same as the phytosanitary certificate. The phytosanitary certificate should indicate, in the appropriate section, that the information belonging in that section is contained in the attachment. The attachment should not contain any information that would not be put on the phytosanitary certificate itself, had there been enough space.

❑ Unacceptable certificates

Importing countries should not accept certificates that they determine to be invalid or fraudulent. The issuing authorities should be notified as soon as possible regarding unacceptable or suspect documents (*see* ISPM No. 13: Guidelines for the notification of non-compliance and emergency action). The NPPO of the exporting country should take corrective action when necessary and maintain systems for vigilance and security to ensure that a high level of confidence is associated with phytosanitary certificates issued by that authority.

➢ Invalid phytosanitary certificates

Reasons for rejecting a phytosanitary certificate and/or for requesting additional information include:

- illegible;
- incomplete;
- period of validity expired or not complied with;
- inclusion of unauthorized alterations or erasures;
- inclusion of conflicting or inconsistent information – use of wording that is inconsistent with the model certificates herein;
- certification of prohibited products;
- non-certified copies.

➢ **Fraudulent certificates**

Fraudulent certificates include those:

- not authorized by the NPPO;
- issued on forms not authorized by the issuing NPPO;
- issued by persons or organizations or other entities that are not authorized by NPPO;
- containing false or misleading information.

❑ **Requirements made by importing countries with respect to preparation and issue of phytosanitary certificates**

Importing countries frequently specify requirements that should be observed with respect to the preparation and issue of phytosanitary certificates. They commonly include:

- language (countries may require that certificates be completed in a specific language or one of a list of languages;
- countries are encouraged to include one of the official languages of FAO);
- period of validity (importing countries may specify the period of time allowed for issue following inspection and/or treatment, dispatch of the consignment from the country of origin following issue, and validity of certificate) ;
- completion (countries may require that the certificate is completed by typing, or in handwritten legible capital letters);
- units (countries may require that the description of the consignment and quantities declared should be done in specified units).

6.2.2. Specific principles and guidelines for preparation and issue of phytosanitary certificates

Phytosanitary certificates and phytosanitary certificates for re-export should include only information related to phytosanitary matters. They should not include statements that requirements have been met and should not include references to animal or human health matters, pesticide residues or radioactivity, or commercial information such as letters of credit. To facilitate cross-referencing between the phytosanitary certificates and documents not related to phytosanitary certification (e.g. letters of credit, bills of lading, CITES certificates), a note may be attached to the phytosanitary certificate which associates the phytosanitary certificate with the identification code, symbol or number(s) of the relevant document(s) which require cross-referencing. Such a note should only be attached when necessary and should not be considered an official part of the phytosanitary certificate. All components of the phytosanitary certificates and phytosanitary certificates for re-export should normally be completed. Where no entry is made, the term 'None' should be entered or the line should be blocked out (to prevent falsification).

❑ **Requirements for completing the phytosanitary certificate**

(Headings in bold refer to the components of the model certificate)
The specific components of the phytosanitary certificate are explained as follows:

No. _____

This is the certificate identification number. It should be a unique serial number associated with an identification system that allows 'trace-back', facilitates audits and serves for record keeping.

Plant Protection Organization of _____
This component requires the name of the official organization and the name of the country that is issuing the certificate. The name of the NPPO may be added here if it is not part of the printed form.

TO: Plant Protection Organization(s) of _____
The name of the importing country should be inserted here. In cases where the shipment transits through a country which has specific transit requirements, including the need for phytosanitary certificates, the names of both importing country and country of transit may be inserted. Care should be taken to ensure that the import and/or transit regulations of each country are met and appropriately indicated. In cases where the shipment is imported and re-exported to another country, the names of both importing countries may be inserted, provided the import regulations of both countries have been met.

Section I. Description of Consignment

Name and address of exporter: _____
This information identifies the source of the consignment to facilitate "trace back" and audit by the exporting NPPO. The name and address should be located in the exporting country. The name and address of a local exporter's agent or shipper should be used, where an international company with a foreign address is the exporter.

Declared name and address of consignee: _____
The name and address should be inserted here and should be in sufficient detail to enable the importing NPPO to confirm the identity of the consignee. The importing country may require that the address be a location in the importing country.

Distinguishing marks: _____
Distinguishing marks may be indicated at this point on the phytosanitary certificate, or else on a stamped and signed attachment to the certificate. Distinguishing marks on bags, cartons or other containers should be included only where they assist in identifying the consignment. Where no entry is made, the term 'None' should be entered or the line should be blocked out (to prevent falsification).

Place of origin: _____
This refers to place(s) from which a consignment gains its phytosanitary status, i.e. where it was possibly exposed to possible infestation or contamination by pests. Normally, this will be the place where the commodity was grown. If a commodity is stored or moved, its phytosanitary status may change over a period of time as a result of its new location. In such cases the new location may be considered as the place of origin. In specific circumstances, a commodity may gain its phytosanitary status from more than one place. In these cases where pests from one or more place may be involved, NPPOs should decide which place or places of origin most accurately describe the situation which has given the commodity its phytosanitary status. In such cases, each place should be declared. It is noted that in exceptional cases, such as with mixed seed lots that have more than one country of origin it is necessary to indicate all possible origins.

Countries may require that 'pest free area', 'pest free place of production', or 'pest free production site' be identified in sufficient detail in this section. In any case, at least the country of origin should be indicated.

Declared means of conveyance: _____
Terms such as 'sea, air, road, rail, mail, and passenger' should be used. The ship's name and voyage number or the aircraft's flight number should be included if known).

Declared point of entry: _____
This should be the first point of arrival in the country of final destination, or if not known, the country name. The point of entry of the first country of importation should be listed where more than one country is listed in the 'TO:' section. The point of entry for the country of final destination should be listed in cases where the consignment only transits through another country. If the country of transit is also listed in the 'TO:' section, the points of entry into the transit country as well as the final destination country may be listed (e.g. point A via point B).

Name of produce and quantity declared: _____
The information provided here should be sufficiently descriptive of the commodity (which should include the commodity class, i.e. fruit, plants for planting, etc.) and the quantity expressed as accurately as possible to enable officials in the importing country to adequately verify the contents of the consignment. International codes may be used to facilitate identification (e.g. customs codes) and internationally recognized units and terms should be used where appropriate. Different phytosanitary requirements may apply to the different end uses (for example, consumption as compared to propagation) or state of a product (e.g. fresh compared to dried); the intended end use or state of the product should be specified. Entries should not refer to trade names, sizes, or other commercial terms.

Botanical name of plants: _____
The information inserted here should identify plants and plant products using accepted scientific names, at least to genus level but preferably to species level. It may not be feasible to provide a botanical description for certain regulated articles and products of complex composition such as stock feeds. In these cases, NPPOs should agree bilaterally on a suitable common name descriptor, or the words 'Not applicable' or 'N/A' may be entered.

Certifying statement
This is to certify that the plants, plant products or other regulated articles described herein have been inspected and/or tested according to appropriate official procedures and are considered to be free from the quarantine pests specified by the importing contracting party and to conform with the current phytosanitary requirements of the importing contracting party, including those for regulated non-quarantine pests.

They are deemed to be practically free from other pests. (Optional clause)

In instances where specific import requirements exist and/or quarantine pests are specified, the certificate is used to certify conformity with the regulations or requirements of the importing country.

In instances where import requirements are not specific and/or quarantine pests are not specified, the exporting country can certify for any pests believed by it to be of regulatory concern.

The exporting countries may include the optional clause on their phytosanitary certificates or not.

"[…] appropriate official procedures […]" refers to procedures carried out by the NPPO or persons authorized by the NPPO for purposes of phytosanitary certification. Such procedures should be in conformity with ISPMs where appropriate. Where ISPMs are not relevant or do not exist, the procedures may be specified by the NPPO of the importing country.

"*[…] considered to be free from quarantine pests […]*" refers to freedom from pests in numbers or quantities that can be detected by the application of phytosanitary procedures. It should not be interpreted to mean absolute freedom in all cases but rather that quarantine pests are not believed to be present based on the procedures used for their detection or elimination. It should be recognized that phytosanitary procedures have inherent uncertainty and variability, and involve some probability that pests will not be detected or eliminated. This uncertainty and probability should be taken into account in the specification of appropriate procedures.

"*[…] phytosanitary requirements […]*" are officially prescribed conditions to be met in order to prevent the introduction and/or spread of pests. Phytosanitary requirements should be specified in advance by the NPPO of the importing country in legislation, regulations, or elsewhere (e.g. import permits and bilateral agreements and arrangements).

"[…] importing contracting party […]" refers to governments that have adhered to the IPPC including Members of the Interim Commission on Phytosanitary Measures until the amendments of 1997 come into force.

Section II. Additional declaration

Additional declarations should be only those containing information required by the importing country and not otherwise noted on the certificate. Additional declarations should be kept to a minimum and be concise. The text of additional declarations may be specified in, for example, phytosanitary regulations, import permits or bilateral agreements. Treatment(s) should be indicated in Section III.

Section III. Disinfestation and/or disinfection treatment

Treatments indicated should only be those which are acceptable to the importing country and are performed in the exporting country or in transit to meet the phytosanitary requirements of the importing country. These can include devitalization and seed treatments.

Stamp of organization: _____
This is the official seal, stamp or mark identifying the issuing NPPO. It may be printed on the certificate or added by the issuing official upon completion of the form. Care should be taken to ensure that the mark does not obscure essential information.

Name of authorized officer, date and signature
The name of the issuing official is typed or hand-written in legible capital letters (where applicable). The date is also to be typed or hand-written in legible capital letters (where

applicable). Only abbreviations may be used to identify months, so that the month, day and year are not confused.

Although portions of the certificate may be completed in advance, the date should correspond to the date of signature. Certificates should not be post- or pre-dated, or issued after dispatch of the consignment unless bilaterally agreed. The NPPO of the exporting country should be able to verify the authenticity of signatures of authorized officers upon request.

Financial liability statement
The inclusion of a financial liability statement in a phytosanitary certificate is optional.

6.2.3. Specific principles and guidelines for preparation and issue of phytosanitary certificates for re-export

The components of the phytosanitary certificate for re-export are the same as for the phytosanitary certificate (see section 2.1) except for the section covering certification. In this section, the NPPO indicates by inserting ticks in the appropriate boxes whether the certificate is accompanied by the original phytosanitary certificate or its certified copy, whether the consignment has been repacked or not, whether the containers are original or new, and whether an additional inspection has been done. ISPM No. 7 (Export Certification Systems) provides guidance on the need for additional inspection.

If the consignment is split up and the resulting consignments are exported separately, then phytosanitary certificates for re-export and certified copies of the original phytosanitary certificate will be required to accompany any such consignments.

❑ **Conditions for issuing a phytosanitary certificate for re-export**

When a consignment is imported into a country, then exported to another, the NPPO should issue a phytosanitary certificate for re-export (see model). The NPPO should only issue a certificate for the export of an imported consignment if the NPPO is confident that the importing country's regulations are met. Re-export certification may still be done if the consignment has been stored, split up, combined with other consignments or re-packaged, provided that it has not been exposed to infestation or contamination by pests. The original phytosanitary certificate or its certified copy should also accompany the consignment.

❑ **Conditions for issuing a phytosanitary certificate for an imported consignment**

If the consignment has been exposed to infestation or contamination by pests, or has lost its integrity or identity, or has been processed to change its nature, the NPPO should issue a phytosanitary certificate and not the phytosanitary certificate for re-export. The country of origin should still be indicated on the phytosanitary certificate. The NPPO must be confident that the importing country’s regulations are met.

If the consignment has been grown for a specific time (depending on the commodity concerned, but usually one growing season or more) the consignment can be considered to have changed its country of origin.

❑ Transit

If a consignment is not imported, but is in transit through a country without being exposed to infestation or contamination by pests, the NPPO does not need to issue either a phytosanitary certificate or a phytosanitary certificate for re-export. If however, the consignment is exposed to infestation or contamination by pests, the NPPO should issue a phytosanitary certificate. If the consignment is split up, combined with other consignments or repackaged, the NPPO should issue a phytosanitary certificate for re-export.

Appendix

Model Phytosanitary Certificate

No. _____

Plant Protection Organization of _____
TO: Plant Protection Organization(s) of _____

I. Description of Consignment

Name and address of exporter: _____
Declared name and address of consignee: _____
Number and description of packages: _____
Distinguishing marks: _____
Place of origin: _____
Declared means of conveyance: _____
Declared point of entry: _____
Name of produce and quantity declared: _____
Botanical name of plants: _____

This is to certify that the plants, plant products or other regulated articles described herein have been inspected and/or tested according to appropriate official procedures and are considered to be free from the quarantine pests specified by the importing contracting party and to conform with the current phytosanitary requirements of the importing contracting party, including those for regulated non-quarantine pests.

They are deemed to be practically free from other pests.*

II. Additional Declaration

III. Disinfestation and/or Disinfection

Date _____ Treatment _____ Chemical (active ingredient) _____
Duration and temperature _____
Concentration _____
Additional information _____
Place of issue _____

(Stamp of Organization) Name of authorized officer_____
Date _____ (Signature) _____

No financial liability with respect to this certificate shall attach to (name of Plant Protection Organization) or to any of its officers or representatives.*

* Optional clause

Model Phytosanitary Certificate for Re-Export

No. _____

Plant Protection Organization of_____ (contracting party of re-export)
TO: Plant Protection Organization(s) of _____ (contracting party[ies] of import)

I. Description of Consignment

Name and address of exporter: _____
Declared name and address of consignee: _____
Number and description of packages: _____
Distinguishing marks: _____
Place of origin: _____
Declared means of conveyance: _____
Declared point of entry: _____
Name of produce and quantity declared: _____
Botanical name of plants: _____

This is to certify that the plants, plant products or other regulated articles described above _____ were imported into (contracting party of re-export) _____ from _____ (contracting party of origin) covered by Phytosanitary certificate No. _____, *original □ certified true copy □ of which is attached to this certificate; that they are packed □ repacked □ in original □ *new □ containers, that based on the original phytosanitary certificate □ and additional inspection □, they are considered to conform with the current phytosanitary requirements of the importing contracting party, and that during storage in _____ (contracting party of re-export), the consignment has not been subjected to the risk of infestation or infection.

* Insert tick in appropriate □ boxes

II. Additional Declaration

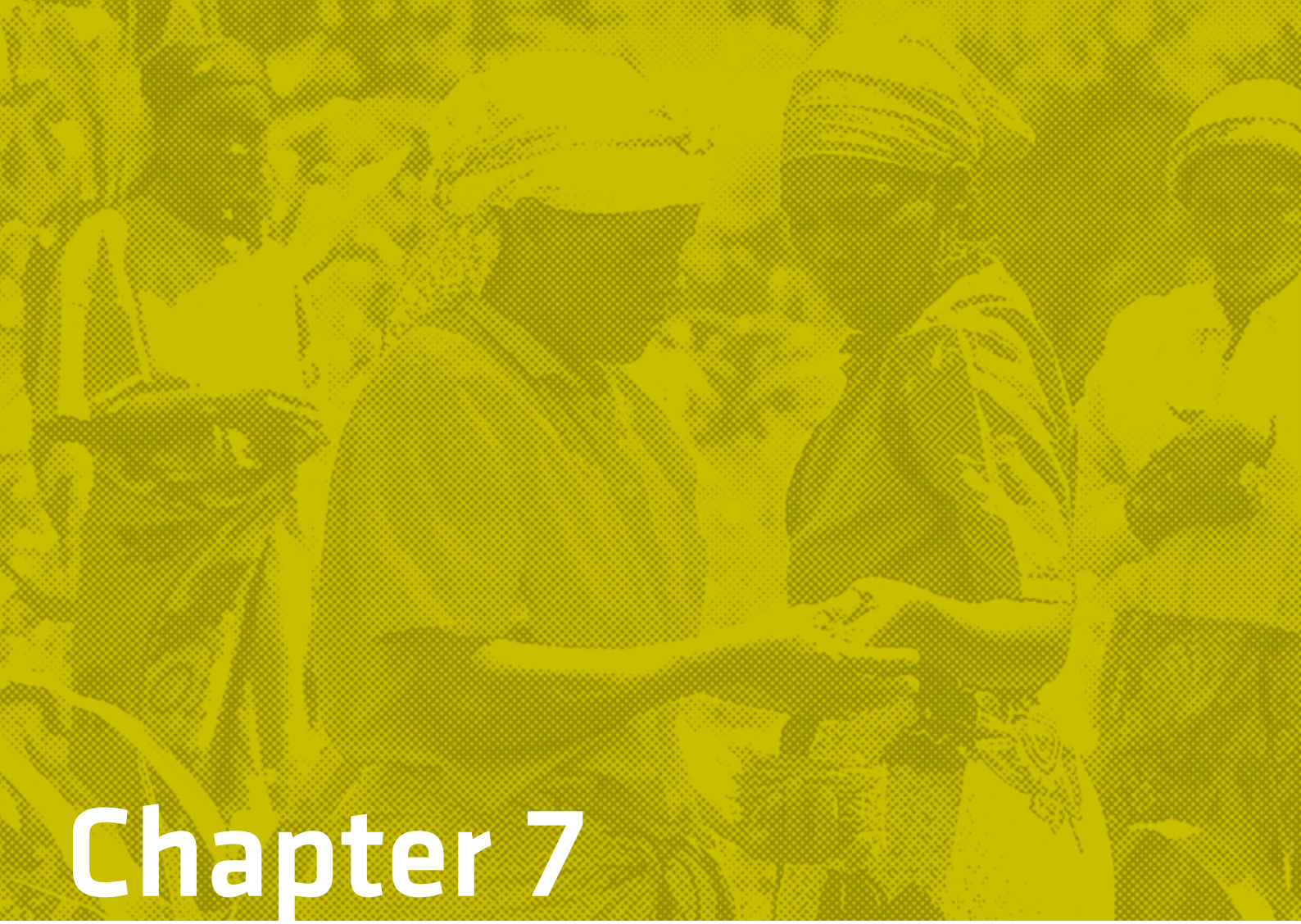
III. Disinfestation and/or Disinfection

Treatment Date _____ Treatment _____ Chemical (active ingredient) _____
Duration and temperature _____
Concentration _____
Additional information _____
_____
Place of issue _____
(Stamp of Organization) Name of authorized officer _____

Date_____ (Signature) _____

No financial liability with respect to this certificate shall attach to (name of Plant Protection Organization) or to any of its officers or representatives.*

* Optional clause



Chapter 7

Guidelines for the notification of non-compliance and emergency action

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7.1. Introduction

This chapter is based on the text of ISPM No. 13.

This standard was endorsed by the Interim Commission on Phytosanitary Measures in April 2001.

7.1.1. Introduction scope

This standard describes the actions to be taken by countries regarding the notification of:

- a significant instance of failure of an imported consignment to comply with specified phytosanitary requirements, including the detection of specified regulated pests;
- a significant instance of failure of an imported consignment to comply with documentary requirements for phytosanitary certification;
- an emergency action taken on the detection in an imported consignment of a regulated pest not listed as being associated with the commodity from the exporting country;
- an emergency action taken on the detection in an imported consignment of organisms posing a potential phytosanitary threat.

7.1.2. References

Determination of pest status in an area, 1998. ISPM No. 8, FAO, Rome.
Export certification systems, 1997. ISPM No. 7, FAO, Rome.
Glossary of phytosanitary terms, 1999. ISPM No. 5, FAO, Rome.
Guidelines for phytosanitary certificates, ISPM No. 12, FAO, Rome.
New Revised Text of the International Plant Protection Convention, 1997. FAO, Rome.

7.1.3. Definitions

Definitions of phytosanitary terms used in the present standard can be found in ISPM No. 5 (*Glossary of phytosanitary terms*).

7.1.4. Outline of requirements

The International Plant Protection Convention (IPPC, 1997) makes provision for contracting parties to report significant instances of non-compliance of imported consignments with phytosanitary requirements, including those related to documentation or to report appropriate emergency action, which is taken on the detection in the imported consignment of an organism posing a potential phytosanitary threat. The importing contracting party is required to notify the exporting contracting party as soon as possible

regarding significant instances of non-compliance and emergency actions applied to imported consignments. The notification should identify the nature of non-compliance in such a way that the exporting contracting party may investigate and make the necessary corrections. Importing contracting parties may request a report of the results of such investigations. Required information for notification includes the reference number, the date of notification, the identity of the NPPOs of the importing and exporting countries, the identity of the consignment and date of first action, the reasons for the action taken, information regarding the nature of non-compliance or emergency action, and the phytosanitary measures applied. Notification should be timely and follow a consistent format. An importing country should investigate any new or unexpected phytosanitary situation where emergency action is taken in order to determine if actions are justified and if changes in phytosanitary requirements are needed. Exporting countries should investigate significant instances of non-compliance to determine the possible cause. Notifications for significant instances of non-compliance or emergency action associated with re-export are directed to the re-export country. Those associated with transit consignments are directed to the exporting country.

7.2. Requirements

7.2.1. Purpose of notifications

Notifications are provided by the importing country to the exporting country to identify significant failures of imported consignments to comply with specified phytosanitary requirements or to report emergency action that is taken on the detection of a pest posing a potential threat. The use of notification for other purposes is voluntary, but in all instances should only be undertaken with the aim of international cooperation to prevent the introduction and/or spread of regulated pests (IPPC Articles I and VIII). In the case of non-compliance the notification is intended to help in investigating the cause of the non-compliance, and to facilitate steps to avoid recurrence.

7.2.2. The use of notification information

Notification is normally bilateral. Notifications and information used for notification are valuable for official purposes but may also be easily misunderstood or misused if taken out of context or used imprudently. To minimize the potential for misunderstandings or abuse, countries should be careful to ensure that notifications and information about notifications are distributed in the first instance only to the exporting country. In particular, the importing country may consult with the exporting country and provide the opportunity for the exporting country to investigate instances of apparent non-compliance, and correct as necessary. This should be done before changes in the phytosanitary status of a commodity or area, or other failures of phytosanitary systems in the exporting country are confirmed or reported more widely (see also good reporting practices for interceptions in ISPM No. 8: Determination of pest status in an area).

7.2.3. Provisions of the IPPC related to notification

The establishment of systems for the routine practice of notification is based on several provisions of the IPPC, summarized as follows:

- Art. VII.2f states, "*Importing contracting parties shall, as soon as possible, inform the exporting contracting party concerned or, where appropriate, the re-exporting contracting party concerned, of significant instances of non-compliance with phytosanitary certification. The exporting contracting party or, where appropriate, the re-exporting contracting party concerned, should investigate and, on request, report the result of its investigation to the importing contracting party concerned*".
- Art. VII.6 states contracting parties may take "*appropriate emergency action on the detection of a pest posing a potential threat to its territories or the report of such a detection. Any such action shall be evaluated as soon as possible to ensure that its continuance is justified. The action taken shall be immediately reported to contracting parties concerned, the Secretary, and any regional plant protection organization of which the contracting party is a member*".
- Art. VIII.1 states that contracting parties shall cooperate in achieving the aims of the Convention.

- Art. VIII.2 states that contracting parties shall designate a contact point for the exchange of information. Countries that are not contracting parties to the IPPC are encouraged to use notification systems described in this standard (IPPC Article XVIII).

7.2.4. Basis for notification

In most instances, notification is provided as the result of the detection of regulated pests in imported consignments. There are also other significant instances of non-compliance that require phytosanitary action and notification. In new or unexpected phytosanitary situations, emergency actions may be taken which should also be notified to the exporting country.

❑ Significant instances of non-compliance

Countries may agree bilaterally on what instances of non-compliance are considered significant for notification purposes. In the absence of such agreements, the importing country may consider the following to be significant:

- failure to comply with phytosanitary requirements;
- detection of regulated pests;
- failure to comply with documentary requirements, including:
  - absence of phytosanitary certificates;
  - uncertified alterations or erasures to phytosanitary certificates;
  - serious deficiencies in information on phytosanitary certificates;
  - fraudulent phytosanitary certificates – prohibited consignments;
- prohibited articles in consignments (e.g. soil);
- evidence of failure of specified treatments - repeated instances of prohibited articles in small, non-commercial quantities carried by passengers or sent by mail.

Significant instances of non-compliance of an imported consignment with phytosanitary requirements should be notified to the exporting country whether or not the consignment requires a phytosanitary certificate.

❑ Emergency Action

Emergency actions are taken on the detection in an imported consignment of:

- regulated pests not listed as being associated with the commodity from the exporting country;
- organisms posing a potential phytosanitary threat.

7.2.5. Timing of notification

Notifications should be provided promptly once non-compliance or the need for emergency action has been confirmed and phytosanitary actions taken. Where there is a significant delay in confirming the reason for the notification (e.g. identification of an organism), a preliminary notification may be provided.

7.2.6. Information included in a notification

Notifications should use a consistent format and include certain minimum information. NPPOs are encouraged to provide additional information where such information is considered relevant and important or has been specifically requested by the exporting country.

❑ Required information

Notifications should include the following information:

- Reference number – the reporting country should have a means of tracing the communication sent to an exporting country. This could be a unique reference number or the number of the phytosanitary certificate associated with the consignment;
- Date – the date on which notification is sent should be noted;
- Identity of the NPPO of the importing country;
- Identity of the NPPO of the exporting country;
- Identity of consignment – consignments should be identified by the phytosanitary certificate number if appropriate or by references to other documentation and including commodity class and scientific name (at least plant genus) for plants or plant products;
- Identity of consignee and consignor;
- Date of first action on the consignment;
- Specific information regarding the nature of the non-compliance and emergency action including:
    - identity of pest (see also section 8 below),
    - where appropriate, whether part or all of the consignment is affected,
    - problems with documentation,
    - phytosanitary requirements to which the non-compliance applies,
- *Phytosanitary actions taken* – the phytosanitary actions should be specifically described and the parts of the consignment affected by the actions identified;
- *Authentication marks* – the notifying authority should have a means for authenticating valid notifications (e.g. stamp, seal, letterhead, authorized signature).

❑ Supporting information

Upon request, supporting information should be made available to the exporting country and may include as appropriate:

- copy of the phytosanitary certificate or other relevant documents;
- diagnostic results;
- pest association, *i.e.* in which part of the consignment the pest was found or how it affects the consignment;
- other information deemed to be useful for the exporting country to be able to identify and correct noncompliance.

❑ **Forms, codes, abbreviations or acronyms**

Where forms, codes, abbreviations or acronyms are used in notification or supporting information, countries should make appropriate explanatory material available on request.

❑ **Language**

The language(s) used for notification and supporting information will be the language(s) preferred by the notifying country except where bilaterally agreed otherwise. Where information is requested through contact points, information should be supplied in one of the FAO languages (IPPC Article XIX.3e).

7.2.7. Documentation and means of communication

The notifying country should keep notification documents, supporting information and associated records for at least one year after the date of notification. Electronic notifications should be used for efficiency and expediency whenever possible. Notification should be sent to the IPPC contact point or, where a contact point has not been identified, to the NPPO of the exporting country unless bilateral arrangements exist which specify to whom the notification should be sent. Communication from official contact points is considered to be authentic unless the NPPO of the importing country indicates other official sources

7.2.8. Pest identification

The identification of organisms detected in imported consignments is required to determine if they are, or should be, regulated pests and to thereby justify phytosanitary or emergency action. Appropriate identification may not be possible where:

- the specimen(s) are of a life stage or condition that makes them difficult to identify,
- appropriate taxonomic expertise is not available.

Where identifications are not possible the reason should be stated on the notification. When identifying pests, importing countries should:

- be able to describe, on request, the procedures used for diagnosis and sampling, including the identity of the diagnostician and/or laboratory, and should retain, for an appropriate period (one year following the notification or until necessary investigation has been carried out), evidence such as appropriate specimens or material to allow validation of potentially controversial determinations;
- indicate the life-stage of the pest and its viability where appropriate;
- provide identification to species level where possible or to a taxonomic level that justifies the official actions taken.

7.2.9. Investigation of non-compliance and emergency action

❑ **Non-compliance**

The exporting country should investigate significant instances of non-compliance to determine the possible cause with a view to avoid recurrence. Upon request, the results of the investigation should be reported to the importing country. Where the results of the investigation indicate a change of pest status, this information should be communicated according to the good practices noted in ISPM No. 8: Determination of pest status in an area.

❑ **Emergency action**

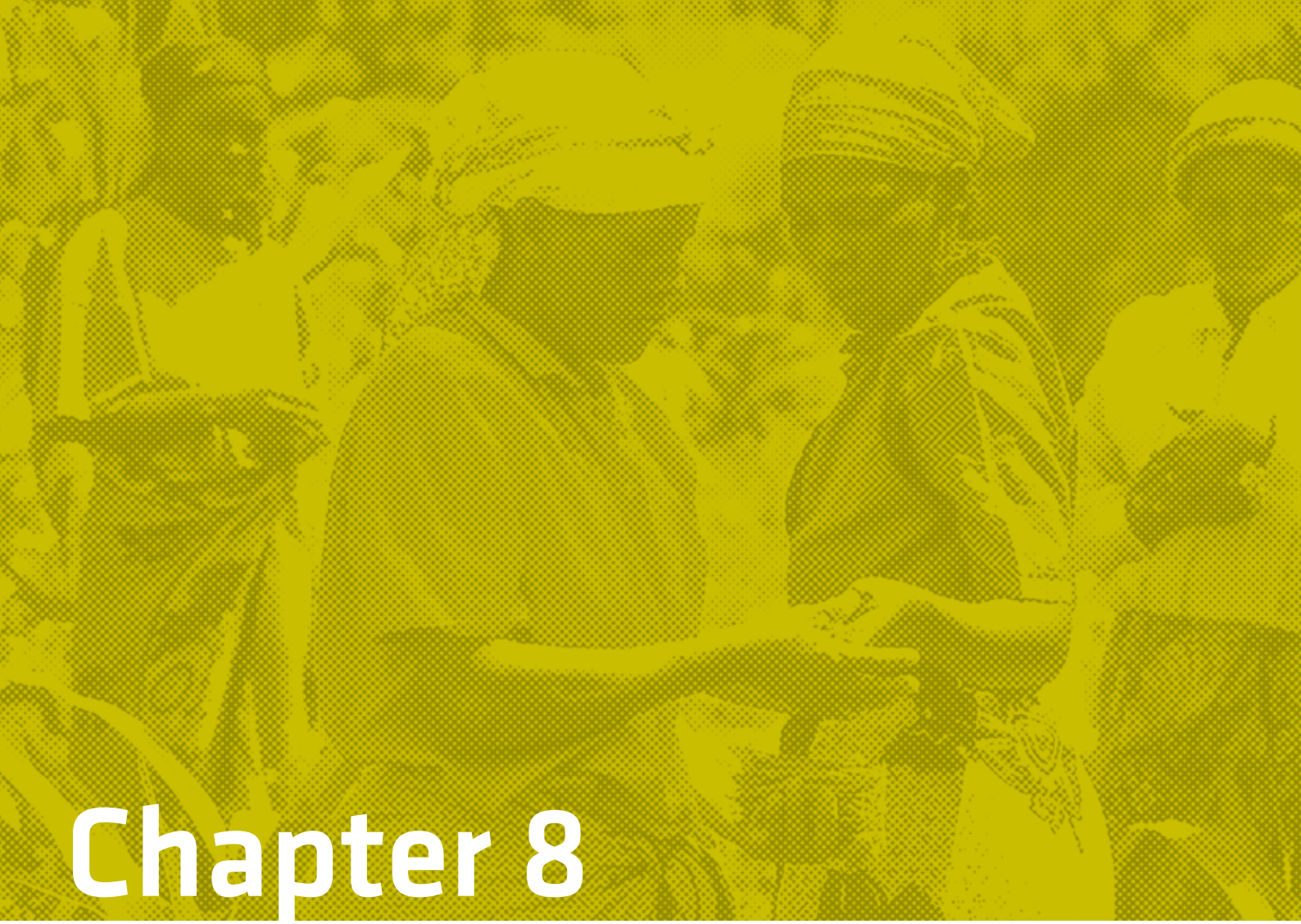
The importing country should investigate the new or unexpected phytosanitary situation to justify the emergency actions taken. Any such action should be evaluated as soon as possible to ensure that its continuance is technically justified. If continuance of actions is justified, phytosanitary measures of the importing country should be adjusted, published and transmitted to the exporting country.

7.2.10. Transit

For a consignment in transit, any instance of non-compliance with the requirements of the transit country or any emergency action taken should be notified to the exporting country. Where the transit country has reason to believe that the non-compliance or new or unexpected phytosanitary situation may be a problem for the country of final destination, the transit country may provide a notification to the country of final destination. The country of final destination may copy its notifications to any transit country involved.

7.2.11. Re-export

In cases associated with a phytosanitary certificate for re-export, the obligation and other provisions pertaining to the exporting country apply to the re-exporting country.



Chapter 8

Glossary of phytosanitary terms

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8.1. Introduction

This chapter is based on the text of ISPM No. 5.

8.1.1. Introduction Scope

This reference standard is a listing of terms and definitions with specific meaning for phytosanitary systems worldwide. It has been developed to provide a harmonized internationally agreed vocabulary associated with the implementation of the International Plant Protection Convention (IPPC) and International Standards for Phytosanitary Measures (ISPMs).

8.1.2. Purpose

The purpose of this reference standard is to increase clarity and consistency in the use and understanding of terms and definitions which are used by contracting parties for official phytosanitary purposes, in phytosanitary legislation and regulations, as well as for official information exchange.

8.1.3. References

Agreement on the Application of Sanitary and Phytosanitary Measures, 1994. World Trade Organization, Geneva.
Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 2000. CBD, Montreal.
Code of conduct for the import and release of exotic biological control agents, 1996. ISPM No. 3, FAO, Rome
Consignments in transit, 2006. ISPM No. 25, FAO, Rome.
Determination of pest status in an area, 1998. ISPM No. 8, FAO, Rome.
Diagnostic protocols for regulated pests, 2006. ISPM No. 27, FAO, Rome.
Export certification system, 1997. ISPM No. 7, FAO, Rome.
FAO Glossary of phytosanitary terms, FAO Plant Protection Bulletin, 38(1) 1990: 5-23.
Glossary of phytosanitary terms, 1995. ISPM No. 5, FAO Rome [published 1996].
Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms, 2005. ISPM No. 3, FAO, Rome.
Guidelines for a phytosanitary import regulatory system, 2004. ISPM No. 20, FAO, Rome.
Guidelines for inspection, 2005. ISPM No. 23, FAO, Rome.
Guidelines for pest eradication programmes, 1998. ISPM No. 9, FAO, Rome.
Guidelines for pest risk analysis, 1996. ISPM No. 2, FAO, Rome.
Guidelines for phytosanitary certificates, 2001. ISPM No. 12, FAO, Rome.
Guidelines for regulating wood packaging material in international trade, 2002. ISPM No. 15, FAO, Rome.
Guidelines for surveillance, 1997. ISPM No. 6, FAO, Rome.
Guidelines for the determination and recognition of equivalence of phytosanitary measures, 2005. ISPM No. 24, FAO, Rome.

Guidelines for the notification of non-compliance and emergency action, 2001. ISPM No. 13, FAO, Rome.
Guidelines on the use of irradiation as a phytosanitary measure, 2003. ISPM No. 18, FAO, Rome.
International Plant Protection Convention, 1997. FAO, Rome.
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Requirements for the establishment of pest free areas, 1996. ISPM No. 4, FAO, Rome.
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8.1.4. Outline of reference

The purpose of this standard is to assist National Plant Protection Organizations and others in information exchange and the harmonization of vocabulary used in official communications and legislation pertaining to phytosanitary measures. The present version incorporates revisions agreed as a result of the approval of the International Plant Protection Convention (1997) and terms added through the adoption of additional International Standards for Phytosanitary Measures (ISPMs).

All elements of this Glossary have been established on the basis that the New Revised Text of the IPPC (1997) is approved. The Glossary contains all terms and definitions approved until the First session of the Commission on Phytosanitary Measures in 2006. References in square brackets refer to the approval of the term and definition, and not to subsequent adjustments in translation.

As in previous editions of the Glossary, terms in definitions are printed in bold to indicate their relation to other Glossary terms and to avoid unnecessary repetition of elements described elsewhere in the Glossary. Derived forms of words that appear in the Glossary, e.g. inspected from inspection, are also considered glossary terms.

8.2. Phytosanitary terms and definitions

Absorbed dose	Quantity of radiating energy (in **gray**) absorbed per unit of mass of a specified target [ISPM No. 18, 2003]
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** [FAO, 1990; revised ICPM, 2005]
Antagonist	An **organism** (usually pathogen) which does no significant damage to the host but its colonization of the host protects the host from significant subsequent damage by a **pest** [ISPM No. 3, 1996]
Area	An **officially** defined country, part of a country or all or parts of several countries [FAO, 1990; revised FAO, 1995; CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures]
Area endangered	See **endangered area**
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** occurs at low levels and which is subject to effective **surveillance**, **control** or **eradication** measures [IPPC, 1997]
Authority	The **National Plant Protection Organization**, or other entity or person officially designated by the government to deal with matters arising from the responsibilities set forth in the Code [ISPM No. 3, 1996]
Bark-free wood	**Wood** from which all bark excluding the vascular cambium, ingrown bark around knots, and bark pockets between rings of annual growth has been removed [ISPM No. 15, 2002]
Beneficial organism	Any **organism** directly or indirectly advantageous to **plants** or **plant products**, including **biological control agents** [ISPM No. 3, 2005]
Biological control	**Pest control** strategy making use of living **natural enemies**, **antagonists**, **competitors** or other **biological control agents** [ISPM No. 3, 1996; revised ISPM No. 3, 2005; formerly **biological control (biocontrol)**]
Biological control agent	A **natural enemy**, **antagonist** or **competitor**, or other **organism**, used for **pest control** [ISPM No. 3, 1996; revised ISPM No. 3, 2005]

Biological pesticide (biopesticide)	A generic term, not specifically definable, but generally applied to a biological control agent, usually a pathogen, formulated and applied in a manner similar to a chemical pesticide, and normally used for the rapid reduction of a **pest** population for short-term **pest control** [ISPM No. 3, 1996]
Buffer zone	An **area** in which a specific **pest** does not occur or occurs at a low level and is **officially controlled**, that either encloses or is adjacent to an infested **area**, an infested **place of production**, an **area of low pest prevalence**, a **pest free area**, a **pest free place of production** or a **pest free production site**, and in which **phytosanitary measures** are taken to prevent **spread** of the **pest** [ISPM No. 10, 1999; revised ISPM No. 22, 2005]
Bulbs and tubers	A **commodity class** for dormant underground parts of **plants** intended for **planting** (includes corms and rhizomes) [FAO, 1990; revised ICPM, 2001]
Certificate	An **official** document which attests to the phytosanitary status of any **consignment** affected by **phytosanitary regulations** [FAO, 1990]
Chemical pressure impregnation	**Treatment** of **wood** with a chemical preservative through a process of pressure in accordance with an official technical specification [ISPM No. 15, 2002; revised ICPM, 2005]
Classical biological control	The intentional introduction and permanent **establishment** of an exotic biological agent for long-term **pest control** [ISPM No. 3, 1996]
Clearance (of a consignment)	Verification of compliance with **phytosanitary regulations** [FAO, 1995]
Commission	The Commission on **phytosanitary measures** established under Article XI [IPPC, 1997]
Commodity	A type of **plant**, **plant product**, or other article being moved for trade or other purpose [FAO, 1990; revised ICPM, 2001]
Commodity class	A category of similar **commodities** that can be considered together in **phytosanitary regulations** [FAO, 1990]
Commodity pest list	A list of **pests occurring** in an **area** which may be associated with a specific **commodity** [CEPM, 1996]
Competitor	An **organism** which competes with pests for essential elements (e.g. food, shelter) in the environment [ISPM No. 3, 1996]
Compliance procedure (for a consignment)	**Official procedure** used to verify that a **consignment** complies with stated phytosanitary requirements [CEPM, 1999]

Consignment	A quantity of **plants**, **plant products** and/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]
Consignment in transit	A **consignment** which passes through a country without being imported, and that may be subject to **phytosanitary measures** [FAO, 1990; revised CEPM, 1996; CEPM 1999; ICPM, 2002; ISPM No. 25, 2006; formerly **country of transit**]
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** and, in the case of **plants** and **plant products**, does not infest those **plants** or **plant products** [CEPM, 1996; revised CEPM, 1999]
Contamination	Presence in a **commodity**, storage place, conveyance or container, of **pests** or other **regulated articles**, not constituting an **infestation** (see **infestation**) [CEPM, 1997; revised CEPM, 1999]
Control (of a pest)	**Suppression**, **containment** or **eradication** of a **pest** population [FAO, 1995]
Control point	A step in a system where specific procedures can be applied to achieve a defined effect and can be measured, monitored, controlled and corrected [ISPM No. 14, 2002]
Controlled area	A **regulated area** which an **NPPO** has determined to be the minimum **area** necessary to prevent spread of a pest from a **quarantine area** [CEPM, 1996]
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]
Cut flowers and branches	A **commodity class** for fresh parts of **plants** intended for decorative use and not for **planting** [FAO, 1990; revised ICPM, 2001]
Debarking	Removal of bark from **round wood** (**debarking** does not necessarily make the **wood** bark-free) [FAO, 1990]
Delimiting survey	**Survey** conducted to establish the boundaries of an **area** considered to be infested by or **free from** a **pest** [FAO, 1990]

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 (see **quarantine**) [FAO, 1990; revised FAO, 1995; CEPM, 1999; ICPM, 2005]
Devitalization	A procedure rendering **plants** or **plant products** incapable of germination, growth or further reproduction [ICPM, 2001]
Dose mapping	Measurement of the **absorbed dose** distribution within a **process load** through the use of **dosimeters** placed at specific locations within the **process load** [ISPM No. 18, 2003]
Dosimeter	A device that, when irradiated, exhibits a quantifiable change in some property of the device which can be related to **absorbed dose** in a given material using appropriate analytical instrumentation and techniques [ISPM No. 18, 2003]
Dosimetry	A system used for determining **absorbed dose**, consisting of **dosimeters**, measurement instruments and their associated reference standards, and procedures for the system's use [ISPM No. 18, 2003]
Dunnage	**Wood packaging material** used to secure or support a **commodity** but which does not remain associated with the commodity [FAO, 1990; revised ISPM No. 15, 2002]
Ecosystem	A dynamic complex of **plant**, animal and micro-organism communities and their abiotic environment interacting as a functional unit [ISPM No. 3, 1996; revised ICPM, 2005]
Efficacy (treatment)	A defined, measurable, and reproducible effect by a prescribed **treatment** [ISPM No. 18, 2003]
Emergency action	A prompt **phytosanitary action** undertaken in a new or unexpected phytosanitary situation [ICPM, 2001]
Emergency measure	A **phytosanitary measure** established as a matter of urgency in a new or unexpected phytosanitary situation. An emergency measure may or may not be a **provisional measure** [ICPM, 2001; 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 [FAO, 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** [FAO, 1995]

Equivalence (of phytosanitary measures)	The situation where, for a specified pest risk, different **phytosanitary measures** achieve a contracting party's appropriate level of protection [FAO, 1995; revised CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures; revised ISPM No. 24, 2005]
Eradication	Application of **phytosanitary measures** to eliminate a **pest** from an **area** [FAO, 1990; revised FAO, 1995; formerly **eradicate**]
Establishment	Perpetuation, for the foreseeable future, of a **pest** within an **area** after **entry** [FAO, 1990; revised FAO, 1995; IPPC, 1997; formerly **established**]
Establishment (of a biological control agent)	The perpetuation, for the foreseeable future, of a **biological control agent** within an **area** after **entry** [ISPM No. 3, 1996]
Exotic	Not native to a particular country, **ecosystem** or **ecoarea** (applied to **organisms** intentionally or accidentally introduced as a result of human activities). As the Code is directed at the **introduction** of **biological control agents** from one country to another, the term "**exotic**" is used for **organisms** not native to a country [ISPM No. 3, 1996]
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]
Fresh	Living; not dried, deep-frozen or otherwise conserved [FAO, 1990]
Fruits and vegetables	A **commodity class** for **fresh** parts of **plants** intended for consumption or processing and not for **planting** [FAO, 1990; revised ICPM, 2001]
Fumigation	**Treatment** with a chemical agent that reaches the **commodity** wholly or primarily in a gaseous state [FAO, 1990; revised FAO, 1995]
Germplasm	**Plants** intended for use in breeding or conservation programmes [FAO, 1990]
Grain	A **commodity class** for **seeds** intended for processing or consumption and not for **planting** (see **seeds**) [FAO, 1990; revised ICPM, 2001]
Gray (Gy)	Unit of **absorbed dose** where 1 Gy is equivalent to the absorption of 1 joule per kilogram (1 Gy = 1 J.kg -1) [ISPM No. 18, 2003]

Growing medium	Any material in which **plant** roots are growing or intended for that purpose [FAO, 1990]
Growing period (of a plant species)	Time period of active growth during a **growing season** [ICPM, 2003]
Growing season	Period or periods of the year when **plants** actively grow in an **area**, **place of production** or production site [FAO, 1990; revised ICPM, 2003]
Habitat	Part of an **ecosystem** with conditions in which an **organism** naturally occurs or can establish [ICPM, 2005]
Harmonisation	The establishment, recognition and application by different countries of **phytosanitary measures** based on common **standards** [FAO, 1995; revised CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures]
Harmonised phytosanitary	**Phytosanitary measures** established by contracting parties to the **IPPC**, based on **international standards** [IPPC, 1997]
Heat treatment	The process in which a **commodity** is heated until it reaches a minimum temperature for a minimum period of time according to an **official** technical specification [ISPM No. 15, 2002; revised ICPM, 2005]
Hitch-hiker pest	See **contaminating pest**
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 No. 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]
Import Permit (of a biological control agent)	An **official** document authorizing importation (of a **biological control agent**) in accordance with specified requirements [ISPM No. 3, 1996]
Inactivation	Rendering micro-organisms incapable of development [ISPM No. 18, 2003]
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 **commodity**)	Presence in a **commodity** of a living **pest** of the **plant** or **plant 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 and/or to determine compliance with **phytosanitary regulations** [FAO, 1990; revised FAO, 1995; formerly **inspect**]
Inspector	Person authorized by a **National Plant Protection Organization** to discharge its functions [FAO, 1990]
Intended use	Declared purpose for which **plants**, **plant products**, or other **regulated articles** are imported, produced, or used [ISPM No. 16, 2002]
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]
Intermediate quarantine	**Quarantine** in a country other than the **country of origin** or destination [CEPM, 1996]
International Plant Protection Convention	International Plant Protection Convention, as deposited with FAO in Rome in 1951 and as subsequently amended [FAO, 1990]
International Standard for Phytosanitary Measures	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 paragraph 1 and 2 of the **IPPC** [IPPC, 1997]
Introduction	The **entry** of a **pest** resulting in its **establishment** [FAO, 1990; revised FAO, 1995; IPPC, 1997]
Introduction (of a **biological control agent)**	The release of a **biological control agent** into an **ecosystem** where it did not exist previously (see **establishment**) [ISPM No. 3, 1996]
Inundative release	The release of large numbers of mass-produced **biological control agents** or **beneficial organisms** with the expectation of achieving a rapid effect [ISPM No. 3, 1996; revised ISPM No. 3, 2005]
Ionizing radiation	Charged particles and electromagnetic waves that as a result of physical interaction create ions by either primary or secondary processes [ISPM No. 18, 2003]
IPPC	**International Plant Protection Convention**, as deposited in 1951 with FAO in Rome and as subsequently amended [FAO, 1990; revised ICPM, 2001]
Irradiation	Treatment with any type of **ionizing radiation** [ISPM No. 18, 2003]

ISPM	**International Standard for Phytosanitary Measures** [CEPM, 1996; revised ICPM, 2001]
Kiln-drying	A process in which **wood** is dried in a closed chamber using heat and/or humidity control to achieve a required moisture content [ISPM No. 15, 2002]
Legislation	Any act, law, regulation, guideline or other administrative order promulgated by a government [ISPM No. 3, 1996]
Living modified organism	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, 2000]
LMO	**Living modified organism** [ISPM No. 11, 2004]
Lot	A number of units of a single **commodity**, identifiable by its homogeneity of composition, origin etc., forming part of a **consignment** [FAO, 1990]
Mark	An **official** stamp or brand, internationally recognized, applied to a **regulated article** to attest its phytosanitary status [ISPM No. 15, 2002]
Micro-organism	A protozoan, fungus, bacterium, virus or other microscopic self-replicating biotic entity [ISPM No. 3, 1996]
Minimum absorbed dose (Dmin)	The localized minimum **absorbed dose** within the **process load** [ISPM No. 18, 2003]
Modern biotechnology	The application of: a. in vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles; or b. fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection. [*Cartagena Protocol on Biosafety to the Convention on Biological Diversity*, 2000]
Monitoring	An **official** ongoing process to verify phytosanitary situations [CEPM, 1996]
Monitoring survey	Ongoing **survey** to verify the characteristics of a **pest** population [FAO, 1995]
National Plant Protection Organization	**Official** service established by a government to discharge the functions specified by the **IPPC** [FAO, 1990; formerly **Plant Protection Organization** (**National**)]

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 No. 3, 1996; revised ISPM No. 3, 2005]
Naturally occurring	A component of an **ecosystem** or a selection from a wild population, not altered by artificial means [ISPM No. 3, 1996]
Non-quarantine pest	**Pest** that is not a **quarantine pest** for an **area** [FAO, 1995]
NPPO	**National Plant Protection Organization** [FAO, 1990; ICPM, 2001]
Occurrence	The presence in an **area** of a **pest officially** recognized to be indigenous or **introduced** and/or not **officially** reported to have been **eradicated** [FAO, 1990; revised FAO, 1995; ISPM No. 17; formerly **occur**]
Official	Established, authorized or performed by a **National Plant Protection Organization** [FAO, 1990]
Official control	The active enforcement of mandatory **phytosanitary regulations** and the application of mandatory **phytosanitary procedures** with the objective of **eradication** or **containment** of **quarantine pests** or for the management of **regulated non-quarantine pests** (see Glossary Supplement No. 1) [ICPM, 2001]
Organism	Any biotic entity capable of reproduction or replication in its naturally occurring state [ISPM No. 3, 1996; revised ISPM No. 3, 2005]
Outbreak	A recently detected **pest** population, including an **incursion**, or a sudden significant increase of an established pest population in an area [FAO, 1995; revised ICPM, 2003]
Packaging	Material used in supporting, protecting or carrying a **commodity** [ISPM No. 20, 2004]
Parasite	An **organism** which lives on or in a larger **organism**, feeding upon it [ISPM No. 3, 1996]
Parasitoid	An insect parasitic only in its immature stages, killing its host in the process of its development, and free living as an adult [ISPM No. 3, 1996]
Pathogen	**Micro-organism** causing disease [ISPM No. 3, 1996]
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** [FAO, 1990; revised FAO, 1995; IPPC, 1997]

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 No. 11, 2001]
Pest diagnosis	The process of detection and identification of a **pest** [ISPM No. 27, 2006]
Pest Free Area	An **area** in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being **officially** maintained [FAO, 1995]
Pest free place of production	**Place of production** in which a specific **pest** does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period [ISPM No. 10, 1999]
Pest free production site	A defined portion of a **place of production** in which a specific **pest** does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period and that is managed as a separate unit in the same way as a **pest free place of production** [ISPM No. 10, 1999]
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 Analysis	The process of evaluating biological or other scientific and economic evidence to determine whether a **pest** should be regulated and the strength of any **phytosanitary measures** to be taken against it [FAO, 1995; revised IPPC, 1997]
Pest risk assessment (for **quarantine pests**)	Evaluation of the probability of the **introduction** and **spread** of a **pest** and of the associated potential economic consequences [FAO, 1995; revised ISPM No. 11, 2001]
Pest risk assessment (for regulated non-quarantine pests)	Evaluation of the probability that a **pest** in **plants for planting** affects the **intended use** of those **plants** with an economically unacceptable impact [ICPM, 2005]
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of **introduction** and **spread** of a **pest** [FAO, 1995; revised ISPM No. 11, 2001]
Pest risk management (for regulated non-quarantine pests)	Evaluation and selection of options to reduce the risk that a **pest** in **plants for planting** causes an economically unacceptable impact on the **intended use** of those **plants** [ICPM, 2005]
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]

PFA	**Pest Free Area** [FAO, 1995; revised ICPM, 2001]
Phytosanitary action	An **official** operation, such as **inspection**, **testing**, **surveillance** or **treatment**, undertaken to implement **phytosanitary measures** [ICPM, 2001; revised ICPM, 2005]
Phytosanitary Certificate	**Certificate** patterned after the model **certificates** of the **IPPC** [FAO, 1990]
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** and/or **spread** of **quarantine pests**, or to limit the economic impact of regulated **non-quarantine pests** [FAO, 1995; revised IPPC, 1997; ICPM, 2002]

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).

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** and/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 FAO, 1995; CEPM, 1999; ICPM, 2001]
Place of production	Any premises or collection of **fields** operated as a single production or farming unit. This may include production sites which are separately managed for phytosanitary purposes [FAO, 1990; revised CEPM, 1999]
Plant pest	See **pest**
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 protection organization (national)	See **National Plant Protection Organization**
Plant quarantine	All activities designed to prevent the **introduction** and/or **spread** of **quarantine pests** or to ensure their **official control** [FAO, 1990; revised FAO, 1995]
Planting (including **replanting)**	Any operation for the placing of **plants** in a **growing medium**, or by grafting or similar operations, to ensure their subsequent growth, reproduction or propagation [FAO, 1990; revised CEPM,1999]
Plants	Living plants and parts thereof, including **seeds** and **germplasm** [FAO, 1990; revised IPPC, 1997]
Plants for planting	**Plants** intended to remain **planted**, to be **planted** or **replanted** [FAO, 1990]
Plants *in vitro*	A **commodity class** for plants growing in an aseptic medium in a closed container [FAO, 1990; revised CEPM, 1999; ICPM, 2002; formerly **plants in tissue culture**]
Point of entry	Airport, seaport or land border point **officially** designated for the importation of **consignments**, and/or entrance of passengers [FAO, 1995]
Post-entry quarantine	**Quarantine** applied to a **consignment** after **entry** [FAO, 1995]
PRA	**Pest Risk Analysis** [FAO, 1995; revised ICPM, 2001]
PRA area	**Area** in relation to which a **Pest Risk Analysis** is conducted [FAO, 1995]
Practically free	Of a **consignment**, **field**, or **place of production**, without **pests** (or a specific **pest**) in numbers or quantities in excess of those that can be expected to result from, and be consistent with good cultural and handling practices employed in the production and marketing of the **commodity** [FAO, 1990; revised FAO, 1995]
Pre-clearance	**Phytosanitary certification** and/or **clearance** in the **country of origin**, performed by or under the regular supervision of the **National Plant Protection Organization** of the country of destination [FAO, 1990; revised FAO, 1995]
Predator	A natural enemy that preys and feeds on other animal **organisms**, more than one of which are killed during its lifetime [ISPM No. 3, 1996]
Process load	A volume of material with a specified loading configuration and treated as a single entity [ISPM No. 18, 2003]
Processed wood material	Products that are a composite of **wood** constructed using glue, heat and pressure, or any combination thereof [ISPM No. 15, 2002]

Prohibition	A **phytosanitary regulation** forbidding the importation or movement of specified **pests** or **commodities** [FAO, 1990; revised FAO, 1995]
Protected area	A **regulated area** that an **NPPO** has determined to be the minimum area necessary for the effective protection of an **endangered area** [FAO, 1990; omitted from FAO, 1995; new concept from CEPM, 1996]
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 **regulated articles** for observation and research or for further **inspection**, **testing** and/or **treatment** [FAO, 1990; revised FAO, 1995; CEPM, 1999]
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; IPPC 1997]
Quarantine station	**Official** station for holding **plants** or **plant products** in **quarantine** [FAO, 1990; revised FAO, 1995; formerly **quarantine station or facility**]
Raw wood	**Wood** which has not undergone processing or **treatment** [ISPM No. 15, 2002]
Re-exported consignment	Consignment that has been imported into a country from which it is then exported. The consignment may be stored, split up, combined with other consignments or have its packaging changed (formerly country of re-export) [FAO, 1990; revised CEPM, 1996; CEPM, 1999; ICPM, 2001; ICPM, 2002]
Reference specimen(s)	Individual specimen(s) from a specific population conserved in a reference culture collection and, where possible, in publicly available collection(s) [ISPM No. 3, 2005]
Refusal	Forbidding **entry** of a **consignment** or other **regulated article** when it fails to comply with **phytosanitary regulations** [FAO, 1990; revised FAO, 1995]
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)**]

Regional standards	**Standards** established by a **Regional Plant Protection Organization** for the guidance of the members of that organization [IPPC, 1997]
Regulated area	An **area** into which, within which and/or from which **plants**, **plant products** and other **regulated articles** are subjected to **phytosanitary regulations** or **procedures** in order to prevent the **introduction** and/or **spread** of **quarantine pests** or to limit the economic impact of **regulated non-quarantine pests** [CEPM, 1996; revised CEPM, 1999; ICPM, 2001]
Regulated article	Any **plant**, **plant product**, storage place, packaging, conveyance, container, soil and any other **organism**, object or material capable of harbouring or spreading **pests**, deemed to require **phytosanitary measures**, particularly where international transportation is involved [FAO, 1990; revised FAO, 1995; IPPC, 1997]
Regulated non-quarantine pest	A **non-quarantine pest** whose presence in **plants for planting** affects the **intended use** of those **plants** with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party [IPPC, 1997]
Regulated pest	A **quarantine pest** or a **regulated non-quarantine pest** [IPPC, 1997]
Release (into the environment)	Intentional liberation of an **organism** into the environment (see **introduction** and **establishment**) [ISPM No. 3, 1996]
Release (of a consignment)	Authorization for **entry** after **clearance** [FAO, 1995]
Replanting	See **planting**
Required response	A specified level of effect for a **treatment** [ISPM No. 18, 2003]
Restriction	A **phytosanitary regulation** allowing the importation or movement of specified **commodities** subject to specific requirements [CEPM, 1996, revised CEPM, 1999]
RNQP	**Regulated non-quarantine pest** [ISPM No. 16, 2002]
Round wood	**Wood** not sawn longitudinally, carrying its natural rounded surface, with or without bark [FAO, 1990]
RPPO	**Regional Plant Protection Organization** [FAO, 1990; revised ICPM, 2001]
sawn wood	**Wood** sawn longitudinally, with or without its natural rounded surface with or without bark [FAO, 1990]
Secretary	**Secretary** of the **Commission** appointed pursuant to Article XII [IPPC, 1997]

Seeds	A **commodity class** for seeds for **planting** or intended for planting and not for consumption or processing (see **grain**) [FAO, 1990; revised ICPM, 2001]
SIT	**Sterile insect technique** [ISPM No. 3, 2005]
Specificity	A measure of the host range of a **biological control agent** on a scale ranging from an extreme specialist only able to complete development on a single species or strain of its host (monophagous) to a generalist with many hosts ranging over several groups of **organisms** (polyphagous) [ISPM No. 3, 1996]
Spread	Expansion of the geographical distribution of a **pest** within an **area** [FAO, 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 of the optimum degree of order in a given context [FAO, 1995; ISO/IEC GUIDE 2:1991 definition]
Sterile insect	An insect that, as a result of a specific treatment, is unable to reproduce [ISPM No. 3, 2005]
Sterile insect technique	Method of **pest control** using area-wide **inundative release** of **sterile insects** to reduce reproduction in a field population of the same species [ISPM No. 3, 2005]
Stored product	Unmanufactured **plant product** intended for consumption or processing, stored in a dried form (this includes in particular **grain** and dried **fruits** and **vegetables**) [FAO, 1990]
Suppression	The application of **phytosanitary measures** in an infested **area** to reduce **pest** populations [FAO, 1995; revised CEPM, 1999]c
Surveillance	An **official** process which collects and records data on **pest occurrence** or absence by **survey**, **monitoring** or other procedures [CEPM, 1996]
Survey	An **official** procedure conducted over a defined period of time to determine the characteristics of a **pest** population or to determine which species **occur** in an **area** [FAO, 1990; revised CEPM, 1996]
Systems approach(es)	The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests [ISPM No. 14, 2002; revised ICPM, 2005]

Technically justified	Justified on the basis of conclusions reached by using an appropriate **pest risk analysis** or, where applicable, another comparable examination and evaluation of available scientific information [IPPC, 1997]
Test	**Official** examination, other than visual, to determine if **pests** are present or to identify **pests** [FAO, 1990]
Transience	Presence of a **pest** that is not expected to lead to **establishment** [ISPM No. 8, 1998]
Transit	See **consignment in transit**
Transparency	The principle of making available, at the international level, **phytosanitary measures** and their rationale [FAO, 1995; revised CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures]
Treatment	**Official** procedure for the killing, **inactivation** or removal of **pests**, or for rendering pests infertile or for **devitalization** [FAO, 1990, revised FAO, 1995; ISPM No. 15, 2002; ISPM No. 18, 2003; ICPM, 2005]
Visual examination	The physical examination of plants, **plant products**, or other **regulated articles** using the unaided eye, lens, stereoscope or microscope to detect **pests** or **contaminants** without **testing** or processing [ISPM No. 23, 2005]
Wood	A **commodity class** for round wood, sawn wood, wood chips or dunnage, with or without bark [FAO, 1990; revised ICPM, 2001]
Wood packaging material	**Wood** or wood products (excluding paper products) used in supporting, protecting or carrying a **commodity** (includes **dunnage**) [ISPM No. 15, 2002]

Appendix

This appendix provides additional clarification of some terms used in this supplement. It is not a prescriptive part of this supplement.

Economic analysis: It primarily uses monetary values as a measure to allow policy makers to compare costs and benefits from different types of goods and services. It encompasses more than the study of market goods and services. Economic analysis does not prevent the use of other measures that do not use a monetary value; for example, qualitative or environmental analysis.

Economic effects: This includes market effects as well as non-market effects, such as environmental and social considerations. Measurement of the economic value of environmental effects or social effects may be difficult to establish. For example, the survival and well-being of another species or the value of the aesthetics of a forest or a jungle. Both qualitative and quantitative worth may be considered in measuring economic effects.

Economic impacts of plant pests: This includes both market measures as well as those consequences that may not be easy to measure in direct economic terms, but which represent a loss or damage to cultivated plants, uncultivated plants or plant products.

Economic value: This is the basis for measuring the cost of the effect of changes (e.g. in biodiversity, ecosystems, managed resources or natural resources) on human welfare. Goods and services not sold in commercial markets can have economic value. Determining economic value does not prevent ethical or altruistic concerns for the survival and well-being of other species based on cooperative behaviour.

Qualitative measurement: This is the valuation of qualities or characteristics in other than monetary or numeric terms.

Quantitative measurement: This is the valuation of qualities or characteristics in monetary or other numeric terms.

Annexes

A.1. Supplement No. 1: Guidelines on the interpretation and application of the concept of official control for regulated pests

❑ Purpose

The words officially controlled express an essential concept in the definition of a quarantine pest. The Glossary of phytosanitary terms defines official as "established, authorized or performed by an NPPO" and control as "suppression, containment or eradication of a pest population". However, for phytosanitary purposes, the concept of official control is not adequately expressed by the combination of these two definitions. The purpose of this guideline is to describe more precisely the interpretation of the concept of official control and its application in practice.

❑ Scope

This guideline refers only to the official control of regulated pests. For the purposes of this guideline, the relevant regulated pests are both quarantine pests that are present in an importing country but not widely distributed and regulated non-quarantine pests.

❑ Definition

Official control is defined as:

The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests.

❑ General requirements

Official control is subject to the "principles of plant quarantine as related to international trade," in particular the principles of non-discrimination, transparency, equivalence and risk analysis. In the case of a quarantine pest that is present but not widely distributed, and where appropriate in the case of certain regulated non-quarantine pests, the importing country should define the infested area(s), endangered area(s) and protected area(s). Official control includes:

- eradication and/or containment in the infested area(s);
- surveillance in the endangered area(s);
- measures related to controls on movement into and within the protected area(s) including measures applied at import.

All official control programmes have elements that are mandatory. At minimum, programme evaluation and pest surveillance are required in official control programmes to determine the need for and effect of control to justify measures applied at import for the same purpose. Measures applied at import should be consistent with the principle of non-discrimination (see below).

For quarantine pests, eradication and containment may have an element of suppression. For regulated non-quarantine pests, suppression may be used to avoid unacceptable economic impact as it applies to the intended use of plants for planting.

❑ **Specific requirements**

➢ **Non-discrimination**

Non-discrimination The principle of non-discrimination between domestic and import requirements is fundamental. In particular, requirements for imports should not be more stringent than the effect of official control in an importing country. There should therefore be consistency between import and domestic requirements for a defined pest:

- import requirements should not be more stringent than domestic requirements;
- domestic and import requirements should be the same or have an equivalent effect;
- mandatory elements of domestic and import requirements should be the same;
- the intensity of inspection of imported consignments should be the same as equivalent processes in domestic control programmes;
- in the case of non-compliance, the same or equivalent actions should be taken on imported consignments as are taken domestically;
- if a tolerance is applied within a national programme, the same tolerance should be applied to equivalent imported material. In particular, if no action is taken in the national official control programme because the infestation level does not exceed a particular level, then no action should be taken for an imported consignment if its infestation level does not exceed that same level. Compliance with import tolerance is generally determined by inspection or testing at entry, whereas the tolerance for domestic consignments should be determined at the last point where official control is applied;
- if downgrading or reclassifying is permitted within a national official control programme, similar options should be available for imported consignments.

➢ **Transparency**

The import and domestic requirements for official control should be documented and made available, on request.

➢ **Technical justification (risk analysis)**

Domestic and import requirements should be technically justified and result in non-discriminatory risk management.

➢ **Enforcement**

The domestic enforcement of official control programmes should be equivalent to the enforcement of import requirements. Enforcement should include:

- a legal basis;
- operational implementation;
- evaluation and review;
- official action in case of non-compliance.

➢ **Mandatory nature of official control**

Official control is mandatory in the sense that all persons involved are legally bound to perform the actions required. The scope of official control programmes for quarantine pests is completely mandatory (e.g. procedures for eradication campaigns), whereas the scope for regulated non-quarantine pests is mandatory only in certain circumstances (e.g. official certification programmes).

➢ **Area of application**

An official control programme can be applied at national, sub-national or local area level. The area of application of official control measures should be specified. Any import restrictions should have the same effect as the measures applied internally for official control.

➢ **NPPO authority and involvement in official control**

Official control should:

- be established or recognized by the national government or the NPPO under appropriate legislative authority;
- be performed, managed, supervised or, at minimum, audited/reviewed by the NPPO;
- have enforcement assured by the national government or the NPPO;
- be modified, terminated or lose official recognition by the national government or the NPPO.

Responsibility and accountability for official control programmes rests with the national government. Agencies other than the NPPO may be responsible for aspects of official control programmes, and certain aspects of official control programmes may be the responsibility of sub-national authorities or the private sector.

The NPPO should be fully aware of all aspects of official control programmes in their country. References Report of the ICPM open-ended working group on official control, 22-24 March 2000, Bordeaux, France, IPPC Secretariat, FAO, Rome.

A.2. Supplement No. 2: Guidelines on the understanding of potential economic importance and related terms including reference to environmental considerations

❑ **Purpose and scope**

These guidelines provide the background and other relevant information to clarify potential economic importance and related terms, so that such terms are clearly understood and their application is consistent with the International Plant Protection Convention (IPPC) and the International Standards for Phytosanitary Measures (ISPM). These guidelines also show the application of certain economic principles as they relate to the IPPC's objectives, in particular in protecting uncultivated/unmanaged plants, wild flora, habitats and ecosystems with respect to invasive alien species that are plant pests.

These guidelines clarify that the IPPC:

- can account for environmental concerns in economic terms using monetary or non-monetary values;
- asserts that market impacts are not the sole indicator of pest consequences;
- maintains the right of members to adopt phytosanitary measures with respect to pests for which the economic damage caused to plants, plant products or ecosystems within an area cannot be easily quantified.

They also clarify, with respect to plant pests, that the scope of the IPPC covers the protection of cultivated plants in agriculture (including horticulture or forestry), uncultivated/unmanaged plants, wild flora, habitats and ecosystems.

❑ Background

The IPPC has historically maintained that the adverse consequences of plant pests, including those concerning uncultivated/unmanaged plants, wild flora, habitats and ecosystems, are measured in economic terms. References to the terms economic effects, economic impacts, potential economic importance and economically unacceptable impact and the use of the word economic in the IPPC and in ISPMs has resulted in some misunderstanding of the application of such terms and of the focus of the IPPC.

The scope of the Convention applies to the protection of wild flora resulting in an important contribution to the conservation of biological diversity. However, it has been misinterpreted that the IPPC is only commercially focused and limited in scope. It has not been clearly understood that the IPPC can account for environmental concerns in economic terms. This has created issues of harmonization with other agreements, including the Convention on Biological Diversity and the Montreal Protocol on Substances that Deplete the Ozone Layer.

❑ Economic terms and environmental scope of the IPPC and ISPMs

The economic terms found in the IPPC and ISPMs may be categorized as follows.

Terms requiring judgement to support policy decisions:

- potential economic importance (in the definition for quarantine pest);
- economically unacceptable impact (in the definition for regulated non-quarantine pest);
- economically important loss (in the definition for endangered area).

Terms related to evidence that supports the above judgements:

- limit the economic impact (in the definition for phytosanitary regulation and the agreed interpretation of phytosanitary measure);
- economic evidence (in the definition for Pest Risk Analysis); - cause economic damage (in Article VII.3 of the IPPC, 1997);
- direct and indirect economic impacts (in ISPM No. 11 and ISPM No. 16);
- economic consequences and potential economic consequences (in ISPM No. 11);
- commercial and non-commercial consequences (in ISPM No. 11).

ISPM No. 2 refers to environmental damage as a factor to consider in the assessment of potential economic importance. Section 2.2.3 includes many items demonstrating the broad scope of economic impacts that is intended to be covered.

ISPM No. 11 notes in section 2.1.1.5 with respect to pest categorization, that there should be a clear indication that the pest is likely to have an unacceptable economic impact, which may include environmental impact, in the PRA area. Section 2.3 of the standard describes the procedure for assessing potential economic consequences of an introduction of a pest. Effects may be considered to be direct or indirect. Section 2.3.2.2 addresses analysis of commercial consequences. Section 2.3.2.4 provides guidance on the assessment of the non-commercial and environmental consequences of pest introduction. It acknowledges that certain types of effects may not apply to an existing market that can be easily identified, but it goes on to state that the impacts could be approximated with an appropriate non-market valuation method. This section notes that if a quantitative measurement is not feasible, then this part of the assessment should at least include a qualitative analysis and an explanation of how the information is used in the risk analysis. *Environmental or other undesirable effects of control measures* are covered in section 2.3.1.2 (Indirect effects) as part of the analysis of economic consequences. Where a risk is found to be unacceptable, Section 3.4 provides guidance on the selection of risk management options, including measurements of cost-effectiveness, feasibility and least trade restrictiveness.

In April 2001 the ICPM recognized that under the IPPC's existing mandate, to take account of environmental concerns, further clarification should include consideration of the following five proposed points relating to potential environmental risks of plant pests:

- reduction or elimination of endangered (or threatened) native plant species;
- reduction or elimination of a keystone plant species (a species which plays a major role in the maintenance of an ecosystem);
- reduction or elimination of a plant species which is a major component of a native ecosystem;
- causing a change to plant biological diversity in such way as to result in ecosystem destabilization;
- resulting in control, eradication or management programs that would be needed if a quarantine pest was introduced, and impacts of such programs (e.g. pesticides or the release of non-indigenous predators or parasites) on biological diversity.

Thus it is clear, with respect to plant pests, that the scope of the IPPC covers the protection of cultivated plants in agriculture (including horticulture and forestry), uncultivated/unmanaged plants, wild flora, habitats and ecosystems.

❑ Economic considerations in PRA

➢ Types of economic effects

In PRA, economic effects should not be interpreted to be only market effects. Goods and services not sold in commercial markets can have economic value and economic analysis encompasses much more than the study of market goods and services. The use of the term economic effects provides a framework in which a wide variety of effects (including environmental and social effects) may be analysed. Economic analysis uses a monetary value as a measure to allow policy makers to compare costs and benefits from different types of goods and services. This does not preclude the use of other tools such as qualitative and environmental analyses that may not use monetary terms.

➢ Costs and benefits

A general economic test for any policy is to pursue the policy if its benefit is at least as large as its cost. Costs and benefits are broadly understood to include both market and non-market aspects. Costs and benefits can be represented by both quantifiable measurements and qualitative measurements. Non-market goods and services may be difficult to quantify or measure but nevertheless are essential to consider.

Economic analysis for phytosanitary purposes can only provide information with regard to costs and benefits, and does not judge if one distribution is necessarily better than another distribution of costs and benefits of a specific policy. In principle, costs and benefits should be measured regardless to whom they occur. Given that judgments about the preferred distribution of costs and benefits are policy choices, these should have a rational relationship to phytosanitary considerations.

Costs and benefits should be counted whether they occur as a direct or indirect result of a pest introduction or if a chain of causation is required before the costs are incurred or the benefits realized. Costs and benefits associated with indirect consequences of pest introductions may be less certain than costs and benefits associated with direct consequences. Often, there is no monetary information about the cost of any loss that may result from pests introduced into natural environments. Any analysis should identify and explain uncertainties involved in estimating costs and benefits and assumptions should be clearly stated.

❑ Application

The following criteria [1] should be met before a plant pest is deemed to have potential economic importance:

- a potential for introduction in the PRA area;
- the potential to spread after establishment; and
- a potential harmful impact on plants, for example:
  - crops (for example loss of yield or quality); or
  - the environment, for example damage to ecosystems, habitats, or species; or
  - some other specified value, for example recreation, tourism, aesthetics.

As stated in Section 3, environmental damage, arising from the introduction of a plant pest, is one of the types of damage recognized by the IPPC. Thus, with respect to the third criterion above, contracting parties to the IPPC have the right to adopt phytosanitary measures even with respect to a pest that only has the potential for environmental damage. Such action should be based upon a Pest Risk Analysis that includes the consideration of evidence of potential environmental damage. When indicating the direct and indirect impact of pests on the environment, the nature of the harm or losses arising from a pest introduction should be specified in Pest Risk Analysis.

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[1] With respect to the first and second criteria, IPPC (1997) Article VII.3 states that for pests which may not be capable of establishment, measures taken against these pests must be technically justified.

In the case of regulated non-quarantine pests, because such pest populations are already established, introduction in an area of concern and environmental effects are not relevant criteria in the consideration of economically unacceptable impacts (see ISPM No. 16: Regulated non-quarantine pests: concept and application).

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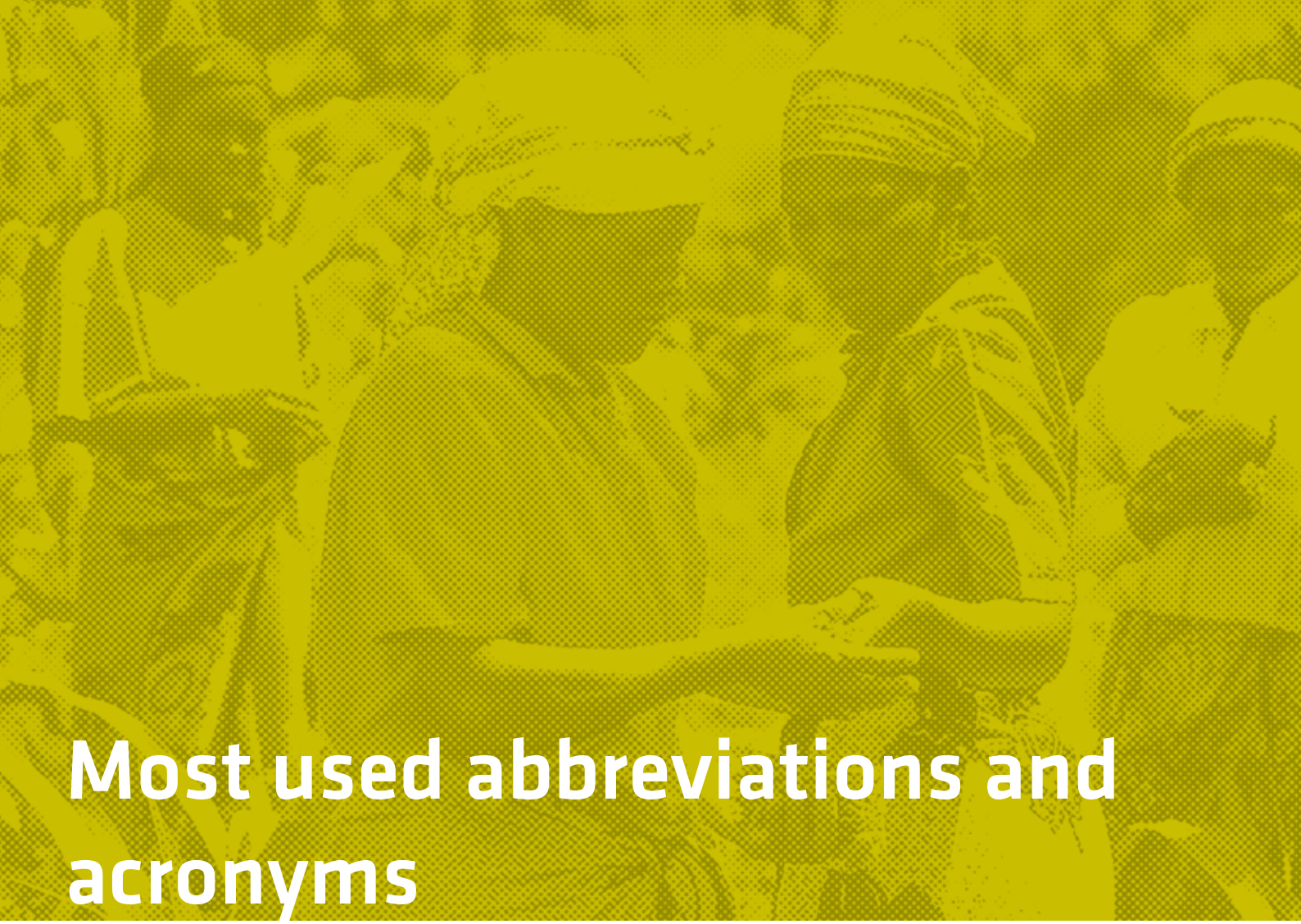
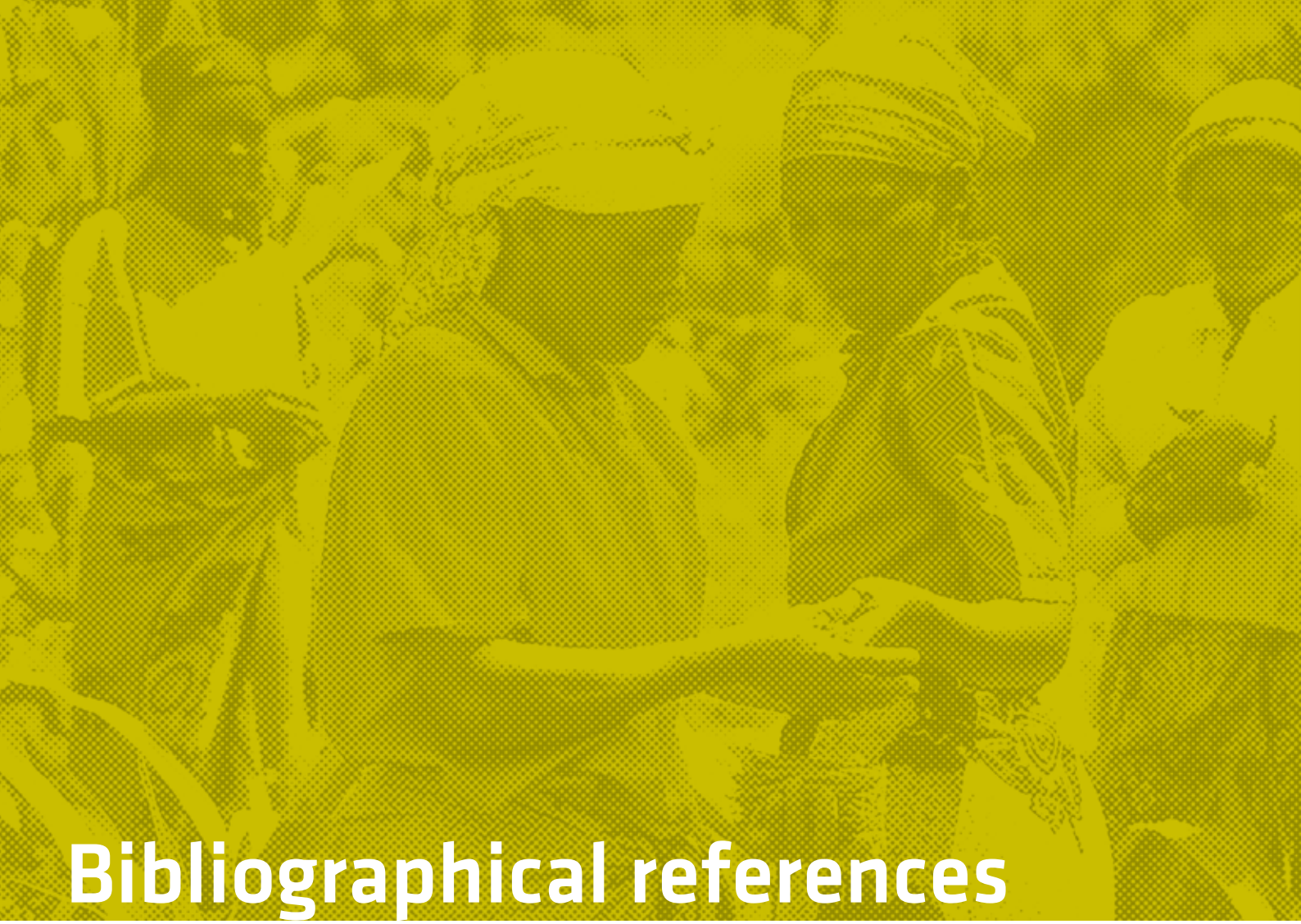


Most used abbreviations and acronyms

Most used abbreviations and acronyms

ACP	African, Caribbean and Pacific Group of States
Aw	Activity Water
CA	Competent Authority
CGIAR	Consultative Group on International Agricultural Research
DNA	Deoxyribonucleic acid
EC	European Community
ECS	European Committee for Standardization
EFSA	European Food Safety Authority
EFTA	European Free Trade Association
ELISA	Enzyme Linked ImmunoSorbent Assay
EPPO	European and Mediterranean Plant Protection Organization
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
HACCP	Hazard analysis and critical control point
INFOSAN	International Food Safety Network
IPPC	International Plant Protection Convention
ISPM	International Standards For Phytosanitary Measures
NPPO	National Plant Protection Organisations
PCR	Polymerase Chain Reaction
PEQ	Post-entry quarantine
pH	Acidity or basicity of an aqueous solution (*Potentiel hydrogène*)
PRA	Pest Risk Analysis

RASFF	Rapid Alert System for Food and Feed
SPS	Sanitary and Phytosanitary Measures
RPPO	Regional Plant Protection Organisations
WHO	World Health Organisation
WTO	World Trade Organisation



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Useful Web sites

Useful Web sites

Afnor: www.boutique.afnor.org/standards-books-information-products

Australia New Zealand Food Standards Code: www.foodstandards.gov.au/scienceandeducation/factsheets/foodsafetyfactsheets/foodrecallsystemsfor104.cfm

Canadian Food Inspection Agency: www.inspection.gc.ca

COLEACP : www.coleacp.org/en

CropScience: www.cropscience.bayer.fr

EPPO: www.eppo.int

EUR-Lex: eur-lex.europa.eu

European Commision: ec.europa.eu/index_en.htm

FAO: www.fao.org/home/en

FAO NIMP: www.fao.org/docrep/010/a0785e/a0785e00.htm

Food and Drug Administration: www.fda.gov/safety/recalls/default.htm

IFS: www.ifs-certification.com/index.php/en

International Plant Protection Convention (IPPC): www.ippc.int/en

ISPM: www.fao.org/docrep/010/a0785e/a0785e00.htm

OMS World Health Organization: www.who.int/en/

RASFF: ec.europa.eu/food/safety/rasff/index_en.htm

Rio Declaration: www.unep.org/documents.multilingual/default.asp?documentid=78&articleid=1163

UNESCO : http://en.unesco.org/

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