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[1]Draft ISPM: *International movement of seeds* (2009-003)

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[24]**Steward history**	[25]2008-11 SC Mr Arundel SAKALA (ZM, Lead Steward) [26]2010-04 SC Mr David PORRITT (AU, Lead Steward) [27]2011-05 SC Mr Marcel BAKAK (CM, Assistant Steward) [28]2012-04 SC Ms Soledad CASTRO-DOROCHESSI (CL, Lead Steward) [29]2012-04 SC Mr David PORRITT (AU, Assistant Steward) [30]2012-11 SC Ms Julie ALIAGA (US, Assistant Steward) [31]2012-11 SC Mr Motoi SAKAMURA (JP, Assistant Steward) [32]2013-11 SC Ms Julie ALIAGA (US, Lead Steward) [33]2013-11 SC Ms Soledad CASTRO-DOROCHESSI (CL, Assistant Steward) [34]2014-11 SC Mr Ezequiel FERRO (AR, Assistant Steward) [35]2015-05 SC Mr Nico HORN (NL, Steward)
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[48]Adoption

[49][Insert text]

[50]INTRODUCTION

[51]Scope

[52]This standard provides guidance to assist national plant protection organizations (NPPOs) in identifying, assessing and managing the pest risk associated with the international movement of seeds (as a commodity class) in the botanical sense.

[53]The standard also provides guidance on procedures to establish phytosanitary import requirements to facilitate the international movement of seeds; on inspection, sampling and testing of seeds; and on procedures for the certification of seeds for export and re-export.

[54]This standard covers seeds imported for laboratory testing or destructive analysis.

[55]This standard does not apply to grain or vegetative plant parts (e.g. tubers of potatoes).

[56]References

[57]The present standard refers to International Standards for Phytosanitary Measures (ISPMs). ISPMs are available on the International Phytosanitary Portal (IPP) at https://www.ippc.int/core-activities/standards-setting/ispms.

[58]Definitions

[59]Definitions of phytosanitary terms used in this standard can be found in ISPM 5 (*Glossary of phytosanitary terms*).

[60]In addition to the definitions in ISPM 5, in this standard the following definitions apply.

[61]**Seed-borne pest**	[62]A pest that is carried by seeds externally or internally and may or may not be transmitted to resultant plants causing their infestation.
[63]**Seed-transmitted pest**	[64]A seed-borne pest that is transmitted via seeds to resultant plants causing their infestation

[65]Outline of Requirements

[66]Seeds, as with other plants for planting, may present a pest risk because seeds may be introduced to an environment where pests may have a high likelihood of establishing and spreading.

[67]Seeds are also regularly moved internationally for research purposes. Therefore, when assessing the pest risk and determining appropriate phytosanitary measures, NPPOs should consider whether the seeds are intended to be used under post-entry quarantine or to be released for planting in the environment in the importing country.

[68]A pest risk analysis (PRA) should determine if the seeds are a pathway for the entry, establishment and spread of quarantine pests in the PRA area. The PRA should consider the purpose for which the seeds are imported (e.g. field planting, research, testing) and the potential for quarantine pests to be introduced or for regulated non-quarantine pests to cause an economically unacceptable impact.

[69]This standard identifies and describes specific phytosanitary measures that may be used to reduce the pest risk associated with the international movement of seeds, including those that may be applied before planting, during growth, at seed harvest, post-harvest, during seed processing, storage and transportation, and on arrival in the importing country. Phytosanitary measures may be used either alone or in combination to manage the pest risk. Equivalent phytosanitary measures may be applied to meet phytosanitary import requirements.

[70]This standard provides guidance on inspection, sampling, testing and the phytosanitary certification of seeds.

[71]BACKGROUND

[72]Seeds are moved internationally for many purposes. Many seeds (including pelleted and coated seeds) are planted for food and ornamental plant production but also for a number of other purposes (e.g. production of biofuels, fibre, forestry, pharmacological uses, pre-commercial uses (research, seed multiplication)).

[73]Under the ISPM 5 definition, seeds are a commodity class used for planting, not for consumption or processing (i.e. for food or animal feed).

[74]As with other plants for planting, seeds may present a pest risk when introduced to an environment where pests may have a high likelihood of establishing and spreading (ISPM 32 (*Categorization of commodities according to their pest risk*)).

[75]Seed companies may have breeding and multiplication programmes in several countries, and may distribute seeds from these countries to many other countries. The international movement of seeds may involve small or large quantities.

[76]Contracting parties face challenges associated with the international movement of seeds that are distinct from the international movement of other types of plants for planting. For example, seeds produced in one country and exported to a second country for processing (e.g. pelleting and coating), testing and packing may then be re-exported to numerous other destinations (including the country of origin). At the time of production of the seeds, the destination country and its phytosanitary import requirements may not be known, especially if a number of years pass between production and export to the final destination. Moreover, breeding, selection and evaluation of seeds are conducted internationally to develop new varieties that are adapted to a range of environments and conditions.

[77]IMPACTS ON BIODIVERSITY AND THE ENVIRONMENT

[78]This standard may help manage the pest risk posed by seeds moved internationally, including the pest risk posed by invasive alien species (as defined in the Convention on Biological Diversity).

[79]Harmonized international phytosanitary measures for seeds may help preserve biodiversity and safeguard the health of stored seeds for future use (e.g. in exchanges between seed banks).

[80]REQUIREMENTS

[81]1. Pest Risk Analysis

[82]PRAs for seeds performed in accordance with ISPM 2 (*Framework for pest risk analysis*), ISPM 11 (*Pest risk analysis for quarantine pests*), ISPM 21 (*Pest risk analysis for regulated non-quarantine pests*) and ISPM 32 should identify the regulated pests potentially associated with seeds and seeds as pests. The PRA should consider the purpose for which seeds are imported (e.g. research, planting, testing) and the probability of regulated pests establishing, spreading and causing economic impacts.

[83]1.1 Seeds as pests

[84]PRA for seeds as pests should follow the guidance provided in Annex 4 of ISPM 11.

[85]1.2 Seeds as pathways

[86]In the pest risk assessment of seeds as pathways, the element of transfer to a suitable host needs further clarification.

[87]Although seed-borne pests are associated with a suitable host upon entry, some pests may result in infection of the host when the seed is planted while others will not.

[88]Seed-borne pests include:

- [89]seed-transmitted pests that are carried internally or externally by the seed and directly infect the host plant developing from the seed (1a)
- [90]non-seed-transmitted pests that are carried by the seed and are transferred to the environment (e.g. water, soil) and then infect a host (1b)
- [91]pests carried by the seed, either internally or externally, that do not transfer to a host (1c).

[92]There is a further category of pests that is relevant even though the pests are not seed-borne pests. This is the category of contaminating pests present in a seed lot (e.g. seeds of plants as pests) (2).

[93]Pests in categories 1a, 1b and 2 should be further assessed for establishment and economic impact. Pests in category 1c cannot establish because they are not transferred to a suitable host.

[94]Examples of these categories are:

[95]1a:

- [96]*Potato spindle tuber viroid* in seed of *Solanum lycopersicum* (tomato seed)
- [97]*Pea seed-borne mosaic virus* in seed of *Pisum sativum* (pea seed)
- [98]*Squash mosaic virus* in seed of *Cucumis melo* (musk melon seed)
- [99]*Clavibacter michiganensis* subsp. *michiganensis* in seed of *Solanum lycopersicum* (tomato seed)
- [100]*Sitophilus oryzae* (rice weevil) in seed of *Oryza sativa* (rice seed)
- [101]*Ditylenchus dipsaci* on or in seed of *Vicia faba* (broad bean) and *Medicago sativa* (alfalfa)
- [102]*Fusarium circinatum* (Pitch canker) in seed of *Pinus* spp.

[103]1b:

- [104]*Gibberella avenaceae* on seed of *Linum usitatissimum* (linseed)
- [105]*Tilletia indica* on seed of *Triticum aestivum* (wheat seed)
- [106]*Pythium* spp. on seed of *Cucumis sativus* (cucumber seed)
- [107]*Megastigmus* sp. (chalcid wasp) on seed of *Abies* spp.

[108]1c:

- [109]*Rice yellow mottle virus* on seed of *Oryza sativa*
- [110]Eggs and larvae of the family Bruchidae (e.g. *Callosobruchus chinensis* and *C. maculatus*)

[111]2:

- [112]Sclerotia of *Sclerotium cepivorum* in seed lots of *Allium cepa* (onion seed)
- [113]*Cyperus iria* in seed lots of *Oryza sativa*
- [114]*Mycosphaerella pini* (Red band disease) in seed lots of *Pinus* spp.

[115]The PRA should consider whether the transmission of pests has been observed or confirmed under natural field conditions or only under artificial conditions (e.g. in a laboratory, control growth room, glasshouse).

[116]Consideration of the biological and epidemiological characteristics of specific pest groups may help in determining the likelihood of a pest being introduced with seeds in an area. Guidance on the likelihood of pest groups being introduced with seeds is provided in Appendix 1 of this standard.

[117]1.3 Purpose of import

[118]The production of seeds may involve several intermediary steps (e.g. breeding, multiplication, destructive analysis, restricted field planting), which may be performed in different countries. The purpose of import of seeds may impact the likelihood of establishment of quarantine pests and should be considered when conducting the PRA and establishing phytosanitary measures (ISPM 32).

[119]During the pest risk assessment, it should be taken into account that pest risk may vary according to the purpose of import. Purpose of import may be broadly ranked from lowest to highest pest risk as follows.

[120]*1.3.1 Seeds for laboratory testing or destructive analysis*

[121]Such seeds are not intended or suitable for planting or for release into the environment of the PRA area.

[122]NPPOs may not require phytosanitary measures for this category of seeds if the pest risk is considered low or negligible.

[123]Seeds imported for testing may be germinated to facilitate testing, but their purpose is not for planting. Requirements for laboratory testing or similar confinement and the destruction of the seeds should be sufficient as a phytosanitary measure.

[124]*1.3.2 Seeds for planting under quarantine conditions*

[125]Such seeds are imported under post-entry quarantine conditions for research and growth in protected environments (e.g. glasshouses, growth chambers) or in isolated fields. These seeds should be planted under conditions that prevent the introduction of quarantine pests into the PRA area. Examples include seeds for evaluation, germplasm, and seeds as breeding material.

[126]For this category, NPPOs should apply phytosanitary measures that are relevant to the assessed pest risk.

[127]*1.3.3 Seeds for planting under field conditions*

[128]Seeds intended for unrestricted release into the PRA area may present the highest pest risk for regulated pests.

[129]The NPPO of the importing country may require phytosanitary measures proportionate with the pest risk. Specific tolerances for regulated non-quarantine pests should be established.

[130]1.4 Mixing and blending of seeds

[131]Mixing of seeds combines different species, varieties or cultivars into a single lot (e.g. lawn grass mixture, wildflower mixture). Blending of seeds combines different seed lots of the same variety.

[132]Seeds from various origins and different harvest years may be mixed and blended.

[133]Mixing and blending of seeds may occur for various reasons. All components of the mixture or blend should meet the relevant import requirements, depending on their respective origin.

[134]In analysing the pest risk of mixed or blended seeds, all combinations of pest, host and origin should be considered. The impacts of the mixing or blending processes (e.g. dilution, increased handling) should also be considered in determining the overall pest risk of mixtures and blends of seeds.

[135]Testing and inspection may be done either on the components or on the mixture or blend to be certified.

[136]All components of the mixture or blend should be traceable. All countries of origin must be listed on the phytosanitary certificate, in accordance with ISPM 12 (*Phytosanitary certificates*).

[137]1.5 Pest risk management in seed production

[138]Certain practices used in seed production may alone or in combination be recognized as phytosanitary measures by the NPPO of the importing country or by the NPPO of the exporting country in order to fulfil the phytosanitary requirements of the importing country. Full documentation of measures applied to the seed consignment should be maintained to facilitate trace-back, as appropriate.

[139]Phytosanitary measures may be included in integrated pest management and quality protocols applied in seed production.

[140]In the case of tree seed, production measures are often only applied at the time of harvest.

[141]Forest tree seeds are harvested in a variety of ways: directly from trees through picking or shaking, from fallen fruits on the ground, from the crown of felled trees, from animal caches of fruits (e.g. conifer cones) and these may affect the pest risk of the seeds. Collection mats or tarpaulins may be spread under trees to minimize soil contamination of seed. Where there is a choice of harvesting methods, minimizing pest infestation should be a consideration.

[142]Production practices may vary between seed production sectors (e.g. field crops, forestry etc.). Options that may be considered when assessing pest risk management include:

[143]Pre-planting:

- [144]use of tested, healthy seed (free of regulated pests)
- [145]seed treatment
- [146]crop management (e.g. rotation or mixed planting)
- [147]field selection
- [148]use of resistant varieties
- [149]soil treatment
- [150]geographical or temporal isolation
- [151]sanitation or disinfection of water

[152]Pre-harvesting:

- [153]hygiene measures (e.g. disinfection of workers' hands and shoes, farm equipment, tools and machinery)
- [154]field inspection and, where appropriate, testing if symptoms are observed
- [155]field sanitation (e.g. removal of symptomatic plants, removal of weeds)
- [156]parent plant testing
- [157]crop treatment
- [158]protected cultivation (e.g. glasshouses, growth chambers)
- [159]sanitation or disinfection of water

[160]Harvesting and post-harvest handling:

- [161]hygiene measures (e.g. disinfection of workers' hands and shoes, farm equipment, machinery and tools)
- [162]timely seed harvest (e.g. just as seed matures, in mast years, from fruit at the pre-ripened stage)
- [163]use of disinfectants during seed extraction

- [164]seed cleaning, drying, conditioning and sorting
- [165]seed sampling for testing to detect pests
- [166]seed storage
- [167]seed treatment (section 1.5.3)
- [168]sanitation (e.g. removing plant debris, soil or visibly infested plants and seeds)
- [169]seed sealing and packaging
- [170]mechanical treatments (e.g. separation of healthy seed).

[171]1.5.1 Seed certification schemes

[172]Certain elements of a seed certification scheme may have an effect on the pest risk of that seed. Some of these elements (e.g. inspection or purity testing for the presence of pests or weed seeds) should be considered in pest risk management by NPPOs and assessed on a case-by-case basis.

[173]Seed certification may be used in combination with other phytosanitary measures. Seed certification schemes should ensure seed traceability.

[174]1.5.2 Resistant plant varieties

[175]Modern breeding programmes may produce plant varieties with a level of resistance to pests, which may include resistance to regulated pests. When confirmed resistance to a regulated pest is such that a resistant variety is not at all infested by the pest, the importing country may consider this resistance as a measure in the framework of a systems approach.

[176]A plant variety's level of resistance to different regulated pests may vary depending on the resistance traits present in the plant. Resistance genes may be effective against all or some specific races, strains, biotypes or pathotypes of the targeted pest but the emergence of new races or biotypes may affect the level of resistance. In addition, some pests may be present asymptomatically. Therefore, the pest resistance should be assessed on a case-by-case basis.

[177]A suggested reference on the use of resistant varieties is provided in Appendix 2.

[178]1.5.3 Seed treatments

[179]Seed treatments include, but are not limited to:

- [180]pesticides (fungicides, insecticides, nematicides and bactericides)
- [181]disinfectants, generally used against bacteria and viruses; disinfection may take place during various steps in seed processing (e.g. seed extraction, seed priming1) or during a dedicated disinfection process
- [183]physical treatments (e.g. dry heat, steam, hot water, irradiation by ultraviolet light, high pressure, deep-freezing)
- [184]biological treatments based on different modes of action, such as antagonism, competition and induced resistance.

[185]2. Phytosanitary Measures

[186]Phytosanitary measures proportionate to the pest risk should be applied alone or in combination to prevent the introduction and spread of quarantine pests and to ensure that the tolerance levels of regulated non-quarantine pests are met, as identified through a PRA.

[187]2.1 Consignment inspection and testing for pest freedom

[188]Seed sample size should be adequate to detect regulated pests.

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[182][1] Seed priming is the pre-treatment of seeds by various methods in order to improve the rate, percentage and uniformity of germination.

[189]2.2 Field inspection for pest freedom

[190]Field inspection may be a phytosanitary measure to detect some regulated pests that produce visible symptoms. If harvested seed shows visual symptoms, it should be tested to confirm the presence of pests.

[191]2.3 Pest free areas, pest free places of production, pest free production sites and areas of low pest prevalence

[192]Pest free areas, pest free places of production or pest free production sites should be recognized, established and maintained in accordance with ISPM 4 (*Requirements for the establishment of pest free areas*), ISPM 10 (*Requirements for the establishment of pest free places of production and pest free production sites*) and ISPM 29 (*Recognition of pest free areas and areas of low pest prevalence*), and should be considered as effective phytosanitary measures.

[193]Areas of low pest prevalence in accordance with ISPM 22 (*Requirements for the establishment of areas of low pest prevalence*) may be used alone or in combination with other phytosanitary measures in a systems approach.

[194]2.4 Phytosanitary treatments

[195]Seed treatments may be used as phytosanitary measures. Seeds may be treated by, for example, heat, hot water, steam, pesticides, biological agents or chemical disinfectants.

[196]Many tropical and some temperate tree species produce seeds which are desiccation sensitive and are particularly prone to latent pest development or pest infestation. Examples include *Quercus robur*, *Acer pseudoplatanus*, *Persea americana* and *Mangifera indica*. Physical or chemical treatments may be applied to prevent latent pest development or pest infestation in seeds that need to be maintained at high moisture levels.

[197]2.5 Post-entry quarantine

[198]NPPOs may establish post-entry quarantine for seeds, including confinement in a quarantine station, in cases where a regulated pest is difficult to detect, where it takes time for symptom expression or where testing or treatment is required. Guidance on post-entry quarantine stations is provided in ISPM 34 (*Design and operation of post-entry quarantine stations for plants*).

[199]As part of post-entry quarantine, a sample of the seed lot may be sown and the resultant plants tested.

[200]The NPPO of the importing country may consider, based on the findings of a PRA, that the pest risk can be adequately managed by requiring the imported seeds to be planted in a designated planting area. The planting area should be isolated from other host plants, and weed control and sanitation and hygiene measures for people, machinery and equipment may be required.

[201]2.6 Prohibition

[202]NPPOs may prohibit importation of seeds of certain species or origins when a PRA determines that the seeds pose a high pest risk and no appropriate phytosanitary measures are available. This includes situations where seeds may pose a high risk of becoming plant pests. Further guidance on prohibition can be found in ISPM 20 (*Guidelines for a phytosanitary import regulatory system*).

[203]The NPPO of the importing country may allow – for research purposes and under an import authorization that indicates specific conditions to prevent the introduction and spread of regulated pests – the entry of seeds that are normally prohibited.

[204]3. Equivalence of Phytosanitary Measures

[205]The equivalence of phytosanitary measures is particularly important for the international movement of seeds as seed companies may have breeding and multiplication programmes in several

countries and may distribute these seeds to other countries, and there may be frequent re-export from a single seed lot (ISPM 1 (*Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade*)).

[206]Determination of the equivalence of phytosanitary measures may be initiated by the exporting country as described in ISPM 24 (*Guidelines for the determination and recognition of equivalence of phytosanitary measures*). The determination may also be initiated by the NPPOs of importing countries by providing multiple options when setting phytosanitary import requirements.

[207]Equivalent phytosanitary measures may provide the NPPO with options to achieve the appropriate level of protection. An example of an equivalent phytosanitary measure may be the substitution of a requirement for field inspection of the seed crop in the country of origin with appropriate seed testing or an effective seed treatment for the regulated pest. ISPM 24 provides further guidance on the equivalence of phytosanitary measures.

[208]For organic seeds requiring chemical treatment, when a chemical is not authorized for use in the country of origin or export, the NPPO of the importing country should consider an alternative measure.

[209]4. Specific Requirements

[210]4.1 Inspection

[211]Inspection may be conducted on the seed consignment or as field inspection of the growing crop, or both, as required. ISPM 23 (*Guidelines for inspection*) and ISPM 31 (*Methodologies for sampling of consignments*) provide further guidance on inspection and sampling.

[212]4.1.1 Inspection of seeds

[213]Seed consignments may be examined for the presence of plants as pests (i.e. weeds, invasive alien plants) and seeds may be examined for signs or symptoms of regulated pests or regulated articles (e.g. soil) or for the presence of contaminating pests. Examination for pest symptoms may be an effective method where infested seeds are known to display characteristic symptoms such as discoloration or shrivelling. For example, infection with *Cercospora kikuchii* in *Glycine max* (soybean) seeds causes purple seed stain, and *Phomopsis longicolla* infection of soybean and *Arachis hypogeae* (peanut) as well as *Cylindrocladium parasiticum* infection of peanut can discolour and shrivel seeds. However, the presence of the pest should be confirmed by laboratory testing.

[214]Visual examination of seeds can be done with or without the help of devices that automatically sort seeds based on visible physical characteristics. Visual examination should be combined with testing methods if pest freedom or a specific tolerance for asymptomatic or unreliably symptomatic regulated pests is required. The majority of seed-borne pests (e.g. nematodes, plants as pests, viruses, viroids, bacteria and fungi) are not detectable by inspection with the naked eye and require a more specialized examination (e.g. with a binocular microscope) or laboratory testing. Inspection after washing or opening seeds may be necessary.

[215]Inspection of seeds that are coated, pelletized or embedded in tape, mats, or any other substrate may require removal of the covering by washing or breaking because the covering material may reduce the ability to see the seed or symptoms of the pest on the seed. In such cases, the NPPO of the importing country may request the NPPO of the exporting country to provide a sample of the seeds before coating, pelleting or treating for inspection and testing, of a size proportional to the seed count, or, alternatively, test the seeds before export and provide the test results.

[216]4.1.2 Field inspection

[217]Inspection of the seed crop in the field may be useful to detect regulated pests known to cause visible symptoms. This requires staff who are trained to recognize the regulated pests and their symptoms and who know the appropriate time during growth at which to inspect the crop for pests. It

should be noted that a pest observed in the field on the mother plant may not necessarily be present in or on the seeds produced by these plants.

[218]4.2 Sampling of lots

[219]Inspection for pests is usually based on sampling. Sampling methodologies used by NPPOs will depend on the sampling objectives (e.g. sampling for testing or inspection) and may be solely statistically based or developed noting particular operational constraints.

[220]Guidance on sampling of consignments for inspection is given in ISPM 31.

[221]4.2.1 Sampling of small lots

[222]Testing of samples that are taken in accordance with ISPM 31 from small lots may result in the destruction of a large proportion of the lot. In such cases, sampling alternatives or equivalent phytosanitary procedures should be considered by the NPPO of the importing country, as per the guidance in ISPM 24.

[223]In cases where sampling from small lots is not possible, specific post-entry quarantine conditions may be determined by the NPPO of the importing country.

[224]4.3 Testing

[225]Inspection may not be sufficient to determine if a regulated pest is present and other forms of examination may be needed (e.g. laboratory testing). Some viruses, viroids, bacteria, fungi, insects and nematodes may not be detectable by inspection of seeds but they may be detectable by specific laboratory tests that follow validated diagnostic protocols for regulated pests.

[226]Molecular and serological diagnostic methods are considered indirect protocols to detect pests in seeds. These methods may give a positive result even when no viable pests are present. Consequently, when testing seeds with these methods, results should be interpreted carefully. Confirmatory tests or additional tests may be required to confirm the presence of a viable pest in a sample. NPPOs should ensure that internationally recognized or validated diagnostic protocols are used to avoid false positives or false negatives. Treated seeds may influence the accuracy of diagnostic testing.

[227]The principles of diagnostic protocols are described in ISPM 27 (*Diagnostic protocols for regulated pests*) and adopted protocols are provided as annexes to ISPM 27. Information on other protocols can be found in the sources listed in Appendix 2 of this standard.

[228]4.3.1 Treated seeds

[229]Ideally, a detection method that detects only viable pests should be used to determine treatment efficacy, so that a negative test result indicates the treatment has been successful. Examples are techniques for the detection of bacteria and fungi where the mycelium will grow on the substrate (i.e. media or blotters), and techniques for the detection of viruses where the seeds are sown and symptoms observed on emerging plants.

[230]The test results of treated seeds should be interpreted carefully, as the following situations may be encountered:

- [231]The treatment inactivates the pest but the detection method detects both viable and non-viable pests. This may be the case with some serological or molecular tests or when detection is based on morphological identification of pests or pest structures that may remain even after treatment (e.g. nematodes, spores). In such cases, determination of the efficacy of the treatment may be inconclusive.
- [232]The treatment physically or chemically inhibits the detection method; for example, some detection methods for bacteria are affected by fungicide treatments.
- [233]The treatment adversely affects the detection method; for example, a method detects only pests present externally and any pests remaining internally after treatment cannot be detected.

In these situations, other detection methods that are able to detect internal infection should be used (e.g. *Xanthomonas campestris* pv. *campestris* cannot be detected externally if the surface of the seeds have been washed for disinfection but may be detected after the seeds have been ground to expose their internal parts).

- [234]The treatment causes false positive, false negative or unreadable results by serological or molecular detection methods. For false negative and unreadable results, preliminary testing should be conducted to verify the detection method: an untreated sample from the same seeds (where no treatment is applied to suppress or inactivate the target pest) or positive control (i.e. a pure culture with the target pest added to the seed extract) should be tested using the same detection method.

[235]5. Phytosanitary Certification

[236]The global and temporal nature of the seed trade (i.e. re-export to many destinations, repeated re-export from the same seed lot, long-term storage) presents phytosanitary certification challenges distinct from those of the international movement of other commodities.

[237]NPPOs are encouraged to exchange official phytosanitary information at export certification with other NPPOs to enable certification for re-export of seeds, as described in ISPM 12. Additional official phytosanitary information, which is not required by the first country of import, may be included on the phytosanitary certificate for export issued by the country of origin when so requested by the exporter in order to facilitate future re-export to other countries (ISPM 12).

[238]An importing country's phytosanitary requirement for a field inspection may not be known at the time of production. The NPPO of the importing country should consider equivalent phytosanitary measures as options to fulfil its phytosanitary import requirements for seeds already harvested, in accordance with ISPM 24.

[239]On phytosanitary certificates, "place of origin" refers primarily to the place(s) where the seeds were grown. If seeds are repacked, stored or moved, the pest risk may change as a result of their new location through possible infestation or contamination by regulated pests. Only if the phytosanitary status of the seeds has changed in one or more of these locations should this country and place be added to the place of origin, which is then placed in parentheses, in accordance with ISPM 12. If different lots within a consignment originate in different places or countries, all countries and places where necessary should be indicated.

[240]6. Record Keeping

[241]Because seeds may be stored for many years before being exported or re-exported, phytosanitary information of the seed lot, and in the case of re-export the phytosanitary certificate for export, should be retained as long as the seed is in storage. NPPOs should use this information as long as is clear that this information relates to the consignment to be certified and only if the relevant import requirements are fulfilled.

[242]This appendix is for reference purposes only and is not a prescriptive part of the standard

[243]APPENDIX 1: Guidance on the likelihood of pest groups being introduced with seeds

[244]For different pest groups their likelihood to be associated with seeds or to be present in consignments of seeds and their potential to establish and spread via this pathway is described (section 1.2 of the standard). This information may be useful in conducting a PRA.

[245]There is limited, and at times conflicting, information available regarding the seed transmission of pests other than insects. In addition, a pest that has been proven to be seed-transmitted in one host is not necessarily seed-transmitted in all known hosts. Factors such as the capability of a host to support transmission or the level of host infection before seed formation should be considered.

[246]NPPOs should consider in their determination of pest–host interaction that plants that may host certain pests under experimental conditions may not be hosts under natural conditions.

[247]1. Arthropods

[248]1.1 Pre-harvest pests

[249]Arthropods in the field may include pests that feed in and on the seeds during the plant growth and seed development period, before harvest.

[250]Arthropods in the field that have a low probability of being present in the consignment of seeds:

- [251]External feeders: arthropods that feed on external parts of seeds may be dislodged during harvesting and cleaning.
- [252]Internal feeders that cause seed abortion: arthropods that feed on internal parts of seeds may cause seeds to fall before maturity and harvest.

[253]Arthropods that are internal feeders on the mature seed in the field have a high probability of being present in seed consignments. Arthropods feeding internally in mature seeds may be present during harvest and may be collected with seeds. Consideration during the pest risk management stage of the PRA is needed to determine whether these arthropods would be visible during quality grading or inspection and whether they would survive storage conditions (e.g. Bruchids).

[254]1.2 Post-harvest pests

[255]Stored product arthropods can infest seeds after harvest, particularly if the seeds are stored in poor conditions (e.g. in high moisture, with previously stored seeds). Good storage conditions, as generally applied for high value seeds, will greatly decrease or remove the likelihood of stored product arthropods feeding on seeds.

[256]Stored product arthropods that are external feeders have a low probability of being present in seed consignments. Arthropods that feed on but are not attached to external parts of seeds may destroy the seed and may pose a risk as contaminating pests. Secondary pests (e.g. *Mycetophagus* spp., *Acarus* spp., *Liposcelis* spp.) may also be present when there is poor sanitation or excessive extraneous matter. Other storage organisms may also be present in poor storage conditions.

[257]Stored product arthropods that are internal feeders have a high probability of being present in seed consignments. Arthropods that feed on internal parts of seeds can infest seeds if they are left exposed before packaging. Consideration should be given to the likelihood of infestation in poor storage conditions.

[258]2. Fungi

[259]Fungal and fungal-like organisms may be associated with seeds both externally and internally without causing disease; however, many species cause seed rot, necrosis, reduced germination and infestation of seedlings. Seed fungal pathogens can be grouped as field pathogens and storage

pathogens. Fungi may be present on the surface of seeds or mixed with seeds as contaminating pests, and can be introduced and spread to the host crop or to other crops (e.g. by contamination of the growing medium). Fungi can also be present in the integuments or in the internal part of the seed and be introduced and spread to the host crop in this way.

[260]3. Bacteria

[261]Although not all bacteria are seed-transmitted, bacteria can be found on or within seeds as either external or internal infections, respectively.

[262]4. Viruses

[263]Not all viruses are seed-transmitted. Viruses as a general rule are seed-transmitted only if the seed embryo is infected, although there are exceptions in the *Tobamovirus* genus. For seed-transmitted viruses, the percentage of infected seedlings is often lower than the percentage of infested seeds.

[264]5. Viroids

[265]Seed transmission has been demonstrated for many but not all viroids.

[266]6. Phytoplasmas and Spiroplasmas

[267]Seed transmission of phytoplasmas is not usual. However, there is evidence of seed transmissibility for some phytoplasmas and spiroplasmas.

[268]7. Nematodes

[269]The majority of plant-parasitic nematode species are recorded as internal or external root parasites; however, some species of nematodes are known to attack above-ground plant parts, including seeds (e.g. *Ditylenchus dipsaci* (Kuehn) Filipjev, *Anguina tritici* (Steinbuch) Chitwood and *Anguilla agrostis* (Steinbuch) Filipjev). Nematodes identified as seed-transmitted pests generally are species that are known to be endoparasites (internal feeders). Some species that are ectoparasites (external feeders) have dormant stages in seeds, plant debris and soil (e.g. *Aphelenchoides besseyi* Christie) or become endoparasitic, invading inflorescenses and developing seeds (e.g. *Anguina tritici* (Steinbuch).

[270]8. Plants as Pests

[271]Seeds of plants as pests (e.g. weeds, invasive alien plants, parasitic plants) may be introduced into a country as contaminating pests in seed lots.

[272]If seeds are determined to be a pathway for the introduction and spread of regulated pests, phytosanitary measures may be considered during the pest risk management stage of the PRA.

[273]APPENDIX 2: Bibliography

[274]The references included in this appendix are generally recognized as authoritative. The list is neither comprehensive nor static.

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[310]Potential implementation issues

[311]This section is not part of the standard. The Standards Committee in May 2016 requested the secretariat to gather information on any potential implementation issues related to this draft, please provide details and proposals on how to address these potential implementation issues