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

[2]

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This is not an official part of the standard and it will be modified by the IPPC Secretariat after adoption.	
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[3] **Adoption**

[4] [Insert text]

[5] INTRODUCTION

[6] Scope

[7] This standard provides guidance to assist national plant protection organizations (NPPOs) to identify, assess and manage the pest risk associated with the international movement of seeds.

Motivation: Editorial correction

[8] The standard also provides guidance on (1) criteria for the harmonization of phytosanitary import requirements to facilitate the international movement of seeds; (2) criteria for the harmonization of procedures for re-export of seeds; and (3) inspection and testing of seeds.

[9] This standard applies to seed in the botanical sense. In addition to seeds for planting, the standard covers seeds for laboratory testing or destructive analysis, and seeds for planting under restrictive conditions. This standard does not apply to grain.

Motivation: Contextual clarification

[10] References

[11] **ISPM 2.** 2007. *Framework for pest risk analysis.* Rome, IPPC, FAO.

[12] **ISPM 4.** 1995. *Requirements for the establishment of pest free areas.* Rome, IPPC, FAO.

[13] **ISPM 5.** *Glossary of phytosanitary terms*. Rome, IPPC, FAO.

[14] **ISPM 10.** 1999. *Requirements for the establishment of pest free places of production and pest free production sites.* Rome, IPPC, FAO.

[15] **ISPM 11.** 2013. *Pest risk analysis for quarantine pests.* Rome, IPPC, FAO.

[16] **ISPM 12.** 2011. *Phytosanitary certificates*. Rome, IPPC, FAO.

[17] **ISPM 13.** 2001. *Guidelines for the notification of non-compliance and emergency action.* Rome, IPPC, FAO.

ISPM 14. 2001. *The use of integrated measures in a systems approach for pest risk management*. Rome, IPPC, FAO.

Motivation: Technical and essential addition - "Integrated measures in a systems approach" is used by many seed companies in prevention and/or hygiene programmes to manage pest risks in seed production.

[18] **ISPM 20.** 2004. *Guidelines for a phytosanitary import regulatory system.* Rome, IPPC, FAO.

[19] **ISPM 21.** 2004. *Pest risk analysis for regulated non-quarantine pests.* Rome, IPPC, FAO.

[20] **ISPM 23.** 2005. *Guidelines for inspection.* Rome, IPPC, FAO.

ISPM 24. 2011. Guidelines for the determination and recognition of equivalence of phytosanitary measures

Motivation: Technical and essential addition – The standard provides guidance on the procedure for

establishing equivalence of phytosanitary measures.

[21] **ISPM 27.** 2006. *Diagnostic protocols for regulated pests.* Rome, IPPC, FAO.

[22] **ISPM 31.** 2008. *Methodologies for sampling of consignments.* Rome, IPPC, FAO.

[23] **ISPM 32.** 2009. *Categorization of commodities according to their pest risk*. Rome, IPPC, FAO.

[24] **ISPM 34.** 2010. *Design and operation of post-entry quarantine stations for plants*. Rome, IPPC, FAO.

[25] **Definitions**

[26] Definitions of phytosanitary terms used in the present standard can be found in ISPM 5 (*Glossary of phytosanitary terms*). In addition to definitions in ISPM 5, in this standard the following definitions apply:

[27] **Seed-borne pest:** A pest that can be found on the seed (externally) or within the seed (internally) but may or may not be transmitted to progeny plants resulting in infestation.

[28] **Seed-transmitted pest:** A seed-borne pest that can be transmitted via seed to progeny plants resulting in infestation.

[29] **Outline of Requirements**

[30] Under the IPPC definition, “seeds” is a commodity class used for planting, not for consumption or processing for food, feed, biofuel and other uses. Like plants for planting, seeds may present a serious risk of introducing quarantine pests as seed-transmitted pests ~~will~~ may be introduced to an environment for further growth where it may have a high likelihood of establishing and spreading (see ISPM 32:2009).

Motivation: Contextual clarification – the use of the word ‘processing’ is confusing in this ISPM as in the terminology of the seed industry it mainly refers to cleaning and conditioning of seeds. Hence the addition of “for food, feed, biofuel and other uses” to the text.

[31] As well as movement for commercial trade, seeds are also regularly moved internationally for research purposes. When assessing the pest risk and determining appropriate phytosanitary measures, NPPOs should therefore consider whether the material is maintained ~~treated~~ in quarantine conditions or ~~and~~ whether it is intended for release for planting in the importing country.

Motivation: Contextual clarification - the use of the word ‘treated’ is confusing. Quarantine and release for planting should be considered independently; so it is not ‘and’, but ‘or’.

[32] A pest risk analysis (PRA) should determine if the seed is a pathway for the introduction and spread of regulated pests and may lead to establishment of regulated pests in the PRA area. The PRA should consider the relationship between the intended use of the seeds (e.g. planting, research, testing) and the potential for pests to become established.

Motivation: Editorial correction

[33] 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 phytosanitary measures that may be applied before planting, throughout growth, at seed harvest, post-harvest, during seed processing and on arrival in the country of import. The standard recognizes the importance of applying equivalent phytosanitary measures as an option to meet import requirements.

[34] NPPOs may establish specific requirements for the importation of small seed lots either through the use of special import permits or other explicit documentation.

Motivation: Technical and essential addition - In the earliest stages of R&D seed quantities are very small, often only a few hundreds or thousands of individual seeds. The export certification system for large quantities of seed is not always appropriate for such small quantities of seed. Special import permits or other documentation, such as a letter from the authorities, allowing entry of such seed along with elements of traditional phytosanitary certification would work better.

[35] **BACKGROUND**

[36] Many seeds (including treated, pelleted and coated seeds) are moved internationally to be planted, primarily for food and ornamental plant production but also for a number of other purposes (e.g. production of biofuels and fibre, forestation, pharmacological uses, pre-commercial uses (research, seed multiplication and increase)).

Motivation: Contextual clarification - as the word 'increase' is ambiguous and does not fully cover what is intended in this paragraph, the term 'multiplication' has been added.

[37] Seed companies commonly have breeding and multiplication programmes in many countries, and distribute these seeds to many more countries. The international movement of seeds may involve small ~~quantities~~ ~~(e.g. for breeding, trials, selection)~~ or large quantities ~~(after multiplication)~~.

Motivation: Contextual clarification - Large quantities can be used for multiplication and for commercialization. The purpose of this article is to indicate that both small and large quantities of seed are moved internationally. The reason why quantities are small or large is irrelevant.

[38] NPPOs face challenges associated with the international movement of seeds that are distinct from the international movement of other forms of plants for planting. For example, seeds produced in one country and exported to a second country for processing, testing and packing may then be re-exported to numerous other destinations over an extended period of time. At the time of production of the seeds, the destination country and its import requirements may not be known, especially if there are a number of years between production and export to the final destination. Moreover, breeding, selection and evaluation of seeds is conducted internationally to develop new varieties that are adapted to a range of environments and conditions. As a result, seeds moved internationally may be subject to various phytosanitary issues, including:

[39] - movement of seeds into and out of many countries, for which phytosanitary import requirements and diagnostic and inspection methodologies vary

[40] - contradictory phytosanitary measures, unnecessary measures and measures that cannot be fulfilled retrospectively (e.g. field inspections).

[41] This standard should help minimize the risk of the global spread of pests, including those that can be considered plants as pests, and other organisms whose pest risk has not been identified yet.

[42] **IMPACT ON BIODIVERSITY AND THE ENVIRONMENT**

[43] This standard will help manage the pest risk posed by seeds moved internationally, including those pest risks that can be posed by invasive alien species (as defined in the Convention on Biological Diversity).

[44] Harmonized international phytosanitary guidance for seeds will help preserve biodiversity and safeguard the health of stored seeds for future use (e.g. seed banks). The standard will help in the movement and exchange of seeds.

[45] **REQUIREMENTS**

[46] **1. Pest Risk Analysis**

[47] PRAs for seeds should be performed in accordance with ISPM 2:2007, ISPM 11:2013 and ISPM 21:2004. PRAs for seeds should identify the regulated pests potentially associated with seeds moved internationally. The PRA should consider the relationship between the intended use of the seeds (e.g. research, planting, testing) and the potential for quarantine pests to establish. Phytosanitary measures should be applied based on the results of the PRA.

[48] **1.1 Seeds as pathways**

[49] PRAs for seeds are complicated by the fact that some pests are seed-borne but not seed-transmitted.

[50] A distinction should be made between seed-borne pests and seed-transmitted pests.

[51] Some pests that are not seed-borne may be associated with the seed crop and subsequently be carried with a seed lot as contaminating pests (e.g. sclerotia, seeds of plants as pests).

[52] If it has been determined that the particular seed may carry a potential quarantine pest, care should be taken to determine whether the pest in question can actually establish in the PRA area, so as to avoid any unjustified phytosanitary import requirement.

[53] Many studies have documented cases in which ~~transfer~~ transmission by seed of seed-borne pests occurs under laboratory conditions but ~~then~~ such ~~transferral~~ transmission has never been observed under field conditions, adding to the uncertainty of PRA judgements on seeds as pathways.

Motivation: Contextual clarification - for reasons of consistency it is better to use the word 'transmission'

[54] Consideration of biological and epidemiological characteristics of specific pest groups aids in determining the likelihood to infest a seed and its potential of introduction. Characteristics of seed-borne and seed-transmitted pest groups are provided in Annex 1 of this standard. This information may be used as guidance when conducting a PRA.

[55] **1.2 Intended use**

[56] The intended use of seeds (e.g. breeding, multiplication, testing, field planting, growing under NPPO control) moved internationally may impact the probability of establishment. Seeds may be moved for purposes other than planting (i.e. ~~trans-shipment~~ destructive analysis) or may be planted under special conditions. The risk level associated with the intended use should be considered when conducting the PRA and establishing phytosanitary measures (ISPM 32:2009).

Motivation: Contextual clarification - 'destructive analysis' is a better example of what can be an alternative 'intended use' of seeds. Phytosanitary measures should depend on the risk level associated with the intended use of the imported seeds.

[57] There is a range in the level of pest risk that may be associated with the various intended uses of seeds. While recognizing that the rankings may vary depending on circumstance, the risks can be broadly ranked from lowest pest risk to highest pest risk as follows:

[58] 1. Seeds with no potential to germinate or generate plants.

[59] For example, devitalized seeds imported for testing or destructive analysis.

[60] These seeds are not intended or suitable for planting and will not be released into the environment of the PRA area. For this category, NPPOs should not require phytosanitary measures as there is negligible risk.

[61] 2. Seeds not for planting but retaining viability.

[62] For example, seeds used for destructive biochemical analysis, diagnostic test controls and other forms of laboratory testing.

[63] In some cases, these seeds may be germinated to facilitate testing, but they are not intended for planting and will not be released into the environment of the PRA area. Laboratory or similar confinement is sufficient as a phytosanitary measure.

[64] 3. Seeds for planting under restricted conditions and not for general release.

[65] For example, seeds imported for research or for growth in protected environments (e.g. glasshouses, growth chambers).

[66] These seeds are planted under conditions that prevent their release into the environment of the PRA area. The required conditions should be developed by the NPPO of the importing country.

[67] 4. Seeds for planting under restricted conditions with the intention of release.

[68] These seeds are imported under post-entry quarantine conditions~~, with treatment as a phytosanitary measure,~~ and are ~~limited~~ restricted to being grown ~~growth~~ in protected environments (e.g. glasshouses, growth chambers) or with field isolation. Examples include seeds for evaluation and potential release, seeds imported for research, seeds imported for genetic resources/gene banks, and seeds as breeding material.

Motivation: Contextual clarification - treatment of seeds is not a common measure during post-entry quarantine. Resulting plants are only treated, if required.

[69] These seeds are planted under conditions that limit or prevent the introduction of regulated pests into the environment of the PRA area. The required conditions should be developed by the NPPO of the importing country.

Seed imported under post-entry quarantine conditions can be dealt with in two ways; a seed sample is planted and if the resulting plants are found to be disease free, the remainder of the shipment is allowed entry for general planting. Alternately, only the progeny of healthy plants can be used for general release.

Motivation: Contextual clarification - the text provides guidance on dealing with seeds imported under post-entry quarantine conditions.

[70] 5. Seeds for planting.

[71] This class of seeds includes seeds imported with the intent of planting them in the broader environment.

[72] Because these seeds are generally intended for unrestricted release into the environment of the PRA area, this class of seeds presents the highest potential pest risk. The need for suitable phytosanitary measures should be considered.

[73] **2. Phytosanitary Measures**

[74] Phytosanitary measures should be used to prevent the introduction of quarantine pests identified during the PRA and in accordance with the requirements outlined in section 1 of this standard.

[75] **2.1 Seed certification schemes**

[76] Certain elements of a seed certification scheme may already include measures that may be recognized as phytosanitary measures, including testing for the presence of weed seeds.

[77] **2.2 Resistant varieties**

[78] Modern breeding programmes result in plant varieties with multiple resistances to pests, which may include resistance to regulated pests. When confirmed resistance to a regulated pest exists, importing countries should consider this resistance as an alternative phytosanitary measure in the PRA for the importation of these seeds.

Motivation: Contextual clarification - considering pest resistance as a phytosanitary measure can be valid only for varieties with confirmed and adequate resistance. Such a measure cannot be generic for all seeds of a species.

[79] A plant variety's level of resistance to different regulated pests may vary depending on the resistance genes present. Resistance genes may be effective against all or some characterized races or strains or biotypes or pathotypes of the targeted pest but the emergence of new races or biotypes may impact the level of resistance. Therefore, the use of pest resistance as a phytosanitary measure must be assessed on a case-by-case basis. Pest resistance may be a useful measure when used in combination with other phytosanitary measures in an integrated pest management approach.

Motivation: Contextual clarification - it is important that races / strains / biotypes / pathotypes are characterised and correctly identified.

[80] Appendix 1 of this standard lists some references on the use of resistant varieties.

[81] **2.3 Pest free areas, pest free places of production and pest free production sites**

[82] Pest free areas, pest free places of production and pest free production sites should be recognized, established and maintained in accordance with ISPM 4:1995 and ISPM 10:1999.

[83] **2.4 Treatments**

[84] Seed treatments include a variety of techniques that may involve, but are not limited to, heat, hot water, fungicides, insecticides, nematicides and chemical or biological treatments or disinfectants.

Motivation: Contextual clarification - the descriptions of treatments in Appendix 2 includes biological treatments

[85] ~~Some~~ Seed treatments may be used as phytosanitary measures.

If chemical seed treatment is required as a (mandatory) phytosanitary measure, an alternative that is compliant with standards for organic seeds should be permitted.

Motivation: Contextual clarification - setting of a mandatory requirement for seed treatments impedes the import of seeds for producers of organic produce. So an alternative should be offered for that market.

As products and Active Ingredients may not be authorised for use in all countries of production, export and re-export, it is recommended that only the required type of treatment be specified in phytosanitary requirements**.** If a treatment rate is specified it should be the one recommended by the manufacturer.

Motivation: Technical and essential addition - if requirements for seed treatments are detailed to the level of prescribing the product, Active Ingredient and/or the rate of application, international movement of seeds is seriously hindered as countries have very different authorizations for Active Ingredients for seed treatments. Such requirements should not become a technical barrier for trade and so the requirement should be formulated in as generic a manner as possible, e.g. 'treatment of seeds by an effective fungicide'.

[86] Appendix 2 of this standard provides an overview of available types of treatments for each pest category.

[87] **2.5 Packaging**

[88] Seeds should be packed in a way that prevents exposure to pests and prevents tampering.

[89] **2.6 Measures for seed production**

[90] Measures used for seed production could also be applied for pest risk management of seed production. These measures should be implemented bearing in mind the specific crop–pest combination and they should cover all stages of seed production. The measures should ensure full traceability.

[91] A phytosanitary measure approved by the NPPO of the exporting country after consultation with the importing country may be included in pest risk management and hygiene protocols based on best practices. The NPPO of the exporting country should monitor the correct use and implementation of such approved protocols.

[92] Measures that may be recognized and for which the NPPO may develop specific requirements, may include

[93] - Pre-planting:

[94] • use of tested, healthy planting material

[95] • crop rotation

[96] • field selection ~~use of resistant or less susceptible varieties~~
• use of resistant varieties

Motivation: Editorial correction

[97] • soil treatment
• geographical or temporal isolation from potential pest sources

Motivation: Contextual clarification

[98] - Pre-harvest:

[99] • hygiene measures (e.g. disinfection of workers' hands or shoes, equipment)

Motivation: Contextual clarification

[100] • field inspection

[101] • sanitation (e.g. ~~rogueing~~ roguing of infected or suspicious plants, weeds, ~~plant debris~~)

Motivation: Editorial correction on the spelling of a technical term and contextual clarification that removal of plant debris is part of harvest and post-harvest handling (see [112])

[102] • parent plant testing

[103] • crop treatment

[104] • protected ~~conditions~~ environments (e.g. glasshouses, growth chambers)

Motivation: Editorial correction, consistency with language used in [68]

[105] - Harvest and post-harvest handling:

[106] • hygiene measures (e.g. disinfection of workers' hands or shoes, equipment)

Motivation: Contextual clarification

[107] • use of disinfectants during seed extraction

[108] • seed cleaning, conditioning and sorting

Motivation: Contextual clarification – seed conditioning and sorting of infected or "suspicious" seeds and seeds of noxious weeds are important risk mitigation measures routinely used by the seed industry during harvest and post-harvest.

[109] • seed storage

[110] • seed treatment

[111] • seed packaging

[112] • sanitation (e.g. removing plant debris, soil ~~or rogueing of infected plants~~)

Motivation: Contextual clarification – roguing of infected plants would be done at an earlier stage (see [101]).

[113] - Transportation and distribution:

[114] • packaging (e.g. pest proof packaging material)

Motivation: Editorial correction

[115] • maintaining phytosanitary security of the consignment.

[116] **2.7 Post-entry quarantine**

[117] NPPOs may apply post-entry quarantine to seeds considered to pose a high risk of introducing quarantine pests. Guidance on post-entry quarantine stations is provided in ISPM 34:2010.

[118] The NPPO of the importing country may consider, based on the findings of a PRA, that the risk of a regulated pest introduction can be sufficiently managed by requiring the imported seeds to be planted in a designated planting area. The planting area should provide isolation from other host plants, and weed control and hygiene measures for people, machinery and tools should be used as needed.

[119] Isolation may be considered, for example, for importation of a large amount of high risk seeds (requiring post-entry quarantine) from an area with limited pest incidence. Regulated pests for which isolation may be appropriate include symptomatic viruses and viroids that are not known to be vectored by insects. Isolation may not be appropriate for symptomless pathogens or pathogens with insect vectors capable of spreading from the isolation area.

Motivation: Contextual clarification

[120] **2.8 Prohibition**

[121] NPPOs may prohibit importation of seeds of certain species or origins considered high risk if they have no suitable phytosanitary measures. Further guidance on prohibition can be found in ISPM 20:2004. The decision to prohibit import should be based on a PRA.

[122] Guidance on prohibition as an emergency measure is given in ISPM 13:2001.

[123] Importers may request the NPPO of the importing country to permit seeds for research or specialized commercial purposes. The NPPO may allow the entry of such seeds under a permit, which should include specific conditions to prevent the introduction and spread of regulated pests. When a PRA determines that the seeds pose a high risk of becoming plants as pests, prohibition may be considered as a phytosanitary measure.

[124] **3. Equivalence of Phytosanitary Measures**

[125] Equivalence of phytosanitary measures is particularly important for the international movement of seeds because of the global aspects of the seed trade with frequent re-export from the same seed lot. As different phytosanitary measures could be equivalent NPPOs are encouraged to provide multiple options when defining phytosanitary measures, and if the need arises to use the procedures described in ISPM 24:2011 to determine the equivalence of an additional option to existing ones.

Motivation: Technical and essential addition - the availability of equivalent or alternative requirements to comply with phytosanitary requirements of the importing country greatly enhances flexibility when (re-exporting seeds to multiple destination countries which may have differing (or differently formulated) requirements. As the process of bilateral acceptance of equivalent measures is tedious, countries should be encouraged to provide multiple or equivalent options when establishing their phytosanitary requirements. ISPM 24 outlines the procedure to be applied to determine the equivalency of later additional measures to the set of existing multiple options.

Another reason for including alternative options is that the phytosanitary status of seeds may change over time due to the applications of seed treatments. A phytosanitary measure which may be suitable for untreated seeds (e.g. field inspection) may not be appropriate for treated seed. Then the option to test seed in a laboratory is an alternative that should be available. See also [126]

[126] For seeds, an example of an equivalent or alternative phytosanitary measure is substituting a requirement for field inspection of plants for a target pest in the country of origin with an appropriate seed test or an effective seed treatment for the target pest.

[127] **4. Specific Requirements**

[128] **4.1 Inspection**

[129] Inspection may be conducted on the seed lot or as field inspection of the growing crop. ISPM 23:2005 and ISPM 31:2008 provide further guidance on inspection and sampling.

[130] **4.1.1 Inspection of seeds**

[131] Seed lots can be examined for the presence of weed seeds and seeds can be examined for signs or symptoms of regulated pests or regulated articles (e.g. sclerotia, soil). This is an effective method where seeds are known to display characteristic symptoms such as discoloration or shrivelling. For example, infection from *Cercospora kikuchii* in soybean seeds causes purple seed stain. *Phomopsis longicolla* of

soybean and *Arachis hypogeae* and *Cylindrocladium parasiticum* in peanut can discolour and shrivel seeds.

[132] Visual examination can be done manually or by using devices that automatically sort seeds based on visual physical characteristics. Visual examination should be combined with other testing methods if screening for asymptomatic or unreliably symptomatic regulated pests is required. Visual examination can be useful for small seed lots but may need to be combined with other methods for larger lots.

Motivation: Editorial correction

[133] Certain pests (e.g. nematodes) are not detectable by simple inspection and may require a more specialized laboratory examination.

[134] Inspection of coated or pelleted or treated seeds may not be appropriate because the coating or pelleting material or treatment may reduce ~~reduces~~ the ability to see the seed or symptoms of the pest on the seed.

Motivation: Contextual clarification - Not all treatments are 'clear' and a coloured or layered treatment can obscure a disease symptom or the presence of unwanted weed seeds or soil particles.

[135] The NPPO of the importing country may request the NPPO of the exporting country to provide a sample of the seeds before coating or pelleting or treatment to assess the pest risk and in order to determine if import requirements will be necessary.

Motivation: Contextual clarification consistent with the change made above

[136] **4.1.2 Field inspection**

[137] Inspection of plants in the field may be a useful phytosanitary measure for quarantine pests known to produce visible symptoms. The use of this measure requires staff trained to recognize the pests of concern as well as identify the appropriate time to monitor for the pests during crop growth.

It should be noted that a pest observed in the field does not necessarily transmit to the seed or may be treated effectively.

Motivation: Technical and essential addition - as explained in section 1.1. (Seeds as pathways) as well as in the schedule of Annex 1.2, a plant may be host to a pest but this pest is not necessarily transmitted to a next generation of plants via seed.

In case seed is harvested from a field with visual symptoms of a disease observed during field inspection, it should be tested if justified according to the PRA.

Motivation: Technical and essential addition – a pest or disease observed during field inspection that is not necessarily transmitted to the seed or can be treated effectively should be tested on a representative seed sample. PRA will provide the justification for which pests this may apply.

[138] **4.2 Sampling**

[139] Because it is difficult to inspect a seed consignment, inspection for the detection of pests is usually based on some type of sampling. Sampling for inspection may be statistically based or dictated by operational feasibility. Sampling implies a threshold for the level of detection of infestation, infection or contamination.

[140] Guidance on sampling of consignments for inspection is given in ISPM 31:2008.

Specific guidance on sampling of seed is given in ISTA's International Rules for Sampling.

Motivation: Contextual clarification - ISPM 31: 2008 is focussed on sampling consignments of multiple lots. The rules for sampling defined by ISTA are focussed on obtaining a representative sample for testing seeds

from an individual seed lot. This is a useful additional resource. See also reference in Appendix 1.

[141] **4.2.1 Sampling of small lots**

[142] Testing of samples taken from small lots when statistically valid samples are required as per ISPM 31:2008 may result in the destruction of an unacceptably large proportion of the lot. In such cases, equivalent means of meeting phytosanitary import requirements should be explored. Some examples are:

[143] 1. fixed proportion samples (e.g. 10% or less of the seed lot)

Motivation: Contextual clarification – a smaller percentage may be necessary in case of very small lots.

[144] 2. reduced sample size, such as sample size maximized at the number of seeds sampled being ten times the number of mother plants from which the seeds have been harvested (e.g. 20,000 seeds have been harvested from 50 plants; the maximum sample is 500 seeds.

Motivation: Technical and essential addition - this part of the text was inadvertently left out from the standard for member consultation

[145] 3. testing plant material from mother plants (e.g. plant tissue). Plant tissue can include immature seeds prior to physical maturity and that are still attached to the plant.

Motivation: Contextual clarification - numbering corrected. The added sentence provides additional information on plant tissue

[146] **4.2.2 Sampling of seeds in sealed containers**

[147] NPPOs should consider the phytosanitary security of the consignment when designing sampling protocols (e.g. minimizing the number of sealed (air-tight) bags opened to obtain the required samples).

[148] **4.3 Detection**

[149] In certain cases, inspection may not be sufficient to determine if a pest is present and other forms of detection may be needed; for example, laboratory testing. ~~Pests such as~~ Some viruses, viroids, bacteria, fungi and ~~some~~ nematodes may not be detected by inspection of seeds. These pests may instead be detected by specific laboratory tests developed and validated for regulated pests in seeds.

Motivation: Contextual clarification

[150] For detecting pests in or on seeds, particular attention should be paid to the performance criteria (sensitivity, specificity, repeatability and reproducibility) of the diagnostic protocols used. These criteria may be affected by, for example, low titre (the lowest concentration of an organism that can be detected in the test) of the pest in the seed or inhibition by seed components or seed microflora. In order to guarantee performance of the diagnostic protocols, NPPOs are encouraged to apply protocols that have been reviewed by experts or validated.

[151] Further information on available validated and reviewed diagnostic protocols can be found in Appendix 1 of this standard. The general principles of diagnostic protocols are described in ISPM 27:2006.

[152] **4.3.1 Serological and molecular ~~diagnostic~~ detection protocols**

Motivation: Technical and essential correction - As the header of this chapter 4.3 is "Detection", it is consistent to use the term "detection protocols", since the protocols for seed health testing are focused on detection of presence/absence of specific target pests.

[153] ~~Serological and molecular diagnostic tests are considered indirect protocols. They detect specific pest components that may be present even when pests are no longer viable. Consequently, when testing seeds with these methods, results should be interpreted carefully. Because positive results can occur even when~~

~~no viable pests are present, confirmatory direct tests or additional indirect tests may be required, provided the performance criteria are equivalent.~~

Serological and molecular tests detect proteins or nucleic acid specific to the target pest that may be present even when the pest is no longer viable, thereby giving a false positive result. Consequently, when using these methods a positive result should be confirmed by testing seed from the same seed lot using a method that determines the viability of the target pest.

Motivation: Technical and essential correction - since the use of the terms 'direct test protocols' and 'indirect protocols' may raise questions, these terms have been removed. The objective of this section is prevention of false positives due to inclusion of non-viable organism in the test scoring,.

[154] **4.3.2 Treated seeds**

[155] Ideally, treatment efficacy for ~~inactivating~~ de-activating a pest is determined using a detection method that detects only viable pests so that a negative test result indicates the treatment has been successful. Examples of such detection methods are techniques for the detection of fungi where the mycelium will grow on the substrate (i.e. media or blotters), and techniques for the detection of bacteria and fungi where the seeds are sown and symptoms observed on plantlets (i.e. grow-out).

Motivation: Contextual clarification - correct term is de-activating

[156] Test results of treated seeds should be interpreted carefully because treatments may interact with diagnostic tests in several ways:

[157] - The treatment ~~inactivates~~ deactivates the pest but the detection method detects the viable and non-viable pests, which happens with ~~some~~ ~~indirect~~ serological or molecular tests or tests in which 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.

Motivation: Contextual clarification

[158] - The treatment adversely affects the detection method; for example, a method detects only pests present externally but the pest remains present internally after treatment and is not detected. In these situations, other detection methods that are able to detect internal infection should be used (e.g. *Xanthomonas campestris* pv. *campestris* after disinfection is not detected after seeds are soaked but may still be detected after seeds are ground).

Motivation: Editorial correction

[159] - The treatment may physically or chemically inhibit the detection method (e.g. some detection methods for bacteria are affected by fungicide treatments).

[160] - The treatment causes false positive, false negative or unreadable results (in serological or molecular detection methods). For false negative and unreadable results, detection methods should be applied to an untreated sample (where the treatment is not aimed at suppressing or inactivating the target pest), or spiked positive controls (i.e. a pure culture with the target pest added to the seed extract) should be tested by the detection method.

[161] **4.4 Importation of small seed lots**

[162] The NPPO of the importing country may establish specific procedures for the importation of small seed lots (e.g. individual packets of seed) taking into account the intended use, size of the lot, production history and origin of the seeds. In certain cases specific import authorizations e.g. in the form of a licence or permit, as described in ISPM 20:2004, could be applied.

Motivation: Technical and essential addition - there are instances where the quantity of seed in the lot is too small to allow the usual phytosanitary measures required for seed of a given species. In such cases, in

addition to alternative sampling strategies as described above in 4.2.1., the instrument of an import permit, detailing adapted and feasible requirements may be used (see: ISPM 20:2004, 4.2.1 and 4.2.2.)

[163] **5. Phytosanitary Certification**

[164] **5.1 General considerations**

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

Motivation: Contextual clarification

[166] Additional official phytosanitary information, which is not required by the first country of import, attesting to freedom from pests may be included on the phytosanitary certificate when requested by the exporter to facilitate future re-export to other countries. This information should be separated from the additional declaration(s) required by the first country of import, in accordance with ISPM 12:2011.

Motivation: Editorial correction

For re-exports of seed, NPPOs should recognize the information in the additional declaration section 'Additional Official Phytosanitary Information' (AOPI) as valid and not require additional testing or inspection for pests covered here.

Motivation: Technical and essential addition - today some countries do not accept (for re-export purposes) the official statements by the country of origin for pests that the re-exporting country cannot verify independently. So, when country A says it has 'Area Freedom'' for a pest, country B might be obliged to do confirmatory testing that the seed is free of that pest. This way of working is not in line with ISPM 12 (5.II, last section)

Minor variations in the wording of additional declarations may create obstacles to the international movement of seeds that are re-exported to multiple destinations. NPPOs are encouraged to use the standard wording provided in ISPM 12:2011.

Motivation: Technical and essential addition - since seeds produced in a country may be exported and re-exported to many countries the use of recommended wording for additional declarations in Appendix 2 of ISPM 12:2011 is essential. This needs to be re-emphasized in this ISPM for seeds.

NPPOs should not only require citing specific articles of the phytosanitary or other regulation in the additional declaration.

Motivation: Technical and essential addition - as seed is re-exported to destinations that are not known at the time of production, the requirement to only cite the specific article in the phytosanitary regulation of the country of final destination in the additional declarations can become a trade barrier. If citing of the specific article of the phytosanitary or other regulation is required, the actual text of the additional declaration should be required as well.

[167] In some cases, the phytosanitary import requirement for a field inspection is not known at the time of production. NPPOs of the exporting country should consider additional field inspections on the request of the producer to allow future re-export. NPPOs of the importing country should consider equivalent phytosanitary measures as options to fulfil phytosanitary import requirements when seed is already harvested.

[168] "Origin" refers to the place(s) where the seeds were grown. If seeds are stored or moved, the pest risk may change over a period of time as a result of their new location. In such cases, the new location should be added to the place of origin in addition to the country of production, in accordance with ISPM 12:2011. If different lots within a consignment originate from different countries, all countries should be indicated.

Only in case the seed is exposed to a phytosanitary risk in the new location, should additional phytosanitary requirements for the country of distribution be added.

Motivation: Technical and essential addition - some NPPOs set different phytosanitary requirements not only per country of origin but also per country of distribution or country of re-export. This should only be done if there is a risk of change of phytosanitary status of the seeds during storage or handling in the country of distribution or re-export.

[169] **5.2 Mixing and blending of seeds**

[170] Mixing and blending of seeds may occur for various reasons.

[171] - Mixing of seeds combines different species, varieties or cultivars ~~of seeds~~ into a single lot (e.g. grasses, ornamentals).

[172] - Blending of seeds combines different seed lots of the same variety.

[173] Seeds from the same country of origin may be mixed and blended, as can ~~may~~ seeds from various origins.

Motivation: Contextual clarification

[174] Traceability for export and re-export of all original seed lots comprising the mixture or blend should ~~be guaranteed to meet~~ comply with the requirements of the importing country.

Motivation: Contextual clarification

[175] All countries of origin must be listed on the phytosanitary certificate, in accordance with ISPM 12:2011.

[176] In the case of a phytosanitary certificate for re-export, validated copies of the original phytosanitary certificates of the components of the mixture or blend should be attached to the re-export certificate.

[177] **6. Record Keeping**

[178] Because seeds may be stored for many years before being exported or re-exported, records on origin, phytosanitary procedures applied and international movements should be retained for ~~at least five~~ for up to ten years and made available to the NPPO of the importing country upon request.

Motivation: Contextual clarification – while commercial seed may be used up to 5 years, seed lots of parental lines are often used for 10 years

[179] This annex is a prescriptive part of the standard

[180] **ANNEX 1: Guidance on the likelihood for pest groups to be present in the seed pathway and their potential to establish and spread**

[181] **1. Pest Groups**

[182] Pests associated with seeds can be grouped based on information regarding their likelihood to be present in the seed pathway and their potential to establish and spread via this pathway. This information may be useful in conducting a pest risk analysis (PRA).

[183] **1.1 Insects in the field**

[184] Insects in the field are pests that feed on the seed or within the seed during the plant growth and seed development period, before harvest.

[185] Insects in the field that are unlikely to be present in the seed pathway:

[186] - External feeders: insects that feed on external parts of seeds are not attached to the seed and will be dislodged during harvesting and cleaning.

[187] - Internal feeders causing seed abortion: insects that feed on internal parts of seeds ~~causing this damage~~ will cause seed to fall before maturity and harvest.

Motivation: Editorial correction

[188] Insects in the field that may be present in the seed pathway:

[189] - Internal feeders of the mature seed: Insects found internally in mature seeds may be present during harvest and collected with healthy seeds. Further consideration would be needed to determine whether these insects would be visibly obvious during quality grading or quarantine inspection and whether they would survive storage environments and durations (e.g. Bruchidae spp. in certain host species).

[190] **1.2 Stored product insects**

[191] Stored product insects, while they are dependent on opportunistic storage conditions and are unlikely to be present, can infest seeds after harvest, particularly if the seeds are stored under poor conditions. Given the high value of seeds for planting, it is unlikely that ~~commercial~~ seeds would be stored in a manner that would provide stored product insects with an opportunity to infest seeds

Motivation: Contextual clarification - all seed is stored well

[192] Stored product insects that are unlikely to be present in the seed pathway:

[193] - External feeders: insects that feed on external parts of seeds will destroy the seed and pose a risk only as contaminants. External feeders are not attached to the seed. Secondary pests (e.g. *Mycetophagus* spp., *Acarus* spp., *Liposcelis* spp.) may also be present if there is poor sanitation causing excessive extraneous matter.

[194] Stored product insects that may be present in the seed pathway:

[195] - Internal feeders: insects that feed on internal parts of seeds can infest seeds if ~~the seeds~~ they are left exposed for a period before packaging. Consideration should be given as to the likelihood of poor storage conditions, whether infested seeds would be detectable and whether the insect would survive the transport environment.

Motivation: Editorial correction

[196] **1.3 Pests other than insects**

[197] There is limited, and at times conflicting, information available in the published literature regarding the seed transmissibility of pathogens (e.g. *Hop latent viroid* in tomato). In addition, a pathogen that has been proven to be seed-transmissible in one host is not necessarily seed-transmissible in all known hosts. This issue is complicated by several determining factors, such as the capability of the host to support transmission and

the level of host infection.

[198] National plant protection organizations (NPPOs) should consider in the wider determination of pathogen–host interaction that experimental hosts may not be true hosts. The interaction may be purely artificial and not demonstrative that infection would occur in the natural environment.

[199] **1.3.1 Fungi**

[200] Fungal species can be associated with seeds both superficially and internally, though many are not considered to be pathogenic. However, there are species that can cause seed rot, necrosis, reduced germination and disease in resultant 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 contaminants, and can be introduced and spread to the host crop or to other crops (e.g. by soil contamination). Fungi can also be present in the teguments or in the internal part of the seed and be introduced and spread to the host crop in this way.

[201] **1.3.2 Bacteria**

[202] Bacteria can be found on seeds as either external or internal infections. Not all bacteria are seed-transmitted. Bacteria associated with seeds are not capable of establishment without seed transmission.

[203] **1.3.3 Viruses**

[204] Viruses as a general rule are only seed-transmissible if the seed embryo is infected, although there are exceptions in the *Tobamovirus* genus. Not all viruses are seed-transmitted.

[205] **1.3.4 Viroids**

[206] Seed transmission has been demonstrated for many viroids but there are also those for which it has not been demonstrated. Not all viroids are seed-transmitted.

[207] **1.3.5 Phytoplasmas**

[208] Phytoplasmas are primarily known to be spread by infected vegetative propagation material and insect vectors. The seed transmissibility for phytoplasmas has not been demonstrated.

[209] **1.3.6 Nematodes**

[210] The majority of nematodes are known to be internal or external root parasites, though there are some species known to attack above-ground plant parts such as seeds (e.g. *Ditylenchus dipsaci* (Kuehn) Filipjev and *Anguina tritici* (Steinbuch) Chitwood). Nematode species identified as seed-~~transmissible~~ transmitted quarantine pests belong to species that are known to be endoparasites (internal feeders of above-ground plant parts). But other species are ectoparasites (e.g. *Aphelenchoides besseyi* Christie) and have dormant stages in the seed or on plant debris around seeds.

Motivation: Contextual clarification - for reasons of consistency it is better to use the word 'transmitted'"

[211] **1.3.7 Plants as pests**

[212] Weed seeds may be introduced into a country when moving seeds for planting internationally.

[213] **2. Possible Outcomes When Evaluating Whether Seed Can Be a Pathway**

[214] o Phytosanitary measures may be considered when:

[215] • plant species is a host, and seeds can be a pathway for entry and can lead to establishment of the pest

[216] • plant species is not a host, but seeds can be a pathway for entry (contaminating pest) and can lead to establishment of the pest.

[217] o Phytosanitary measures should not be considered when:

[218] • plant species is a host, but seeds are not a pathway for pest introduction

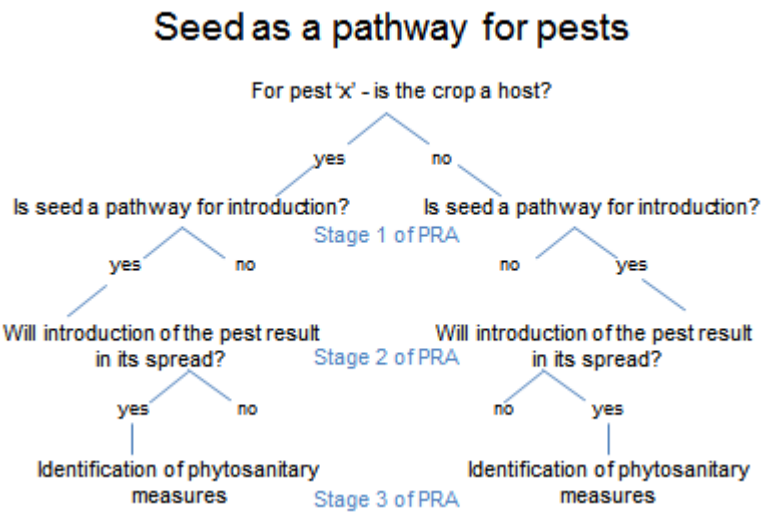
[219] • plant species is a host and seeds can be a pathway for entry but cannot lead to establishment of the pest

[220] • plant species is not a host, but seeds can be a pathway for entry (contaminating pest) but cannot lead to establishment

[221] • plant species is not a host, and seeds are not a pathway for entry.

[222] PRA (see ISPM 2:2007, ISPM 11:2013 and ISPM 21:2004) provides a basis for determining the potential of seeds being a pest risk.

The decision tree below illustrates the possible outcomes when evaluating if seed is a pathway and if phytosanitary measures are required.



Motivation: Technical and essential addition - the decision tree is a useful vizualization of the sequence of questions to be addressed during the PRA process to determine the relevance of seeds as a pathway for the pest concerned and to determine whether the pest warrants phytosanitary measures when importing seeds into the PRA area.

[223] This annex is a prescriptive part of the standard

[224] **ANNEX 2: Forest tree seeds**

[225] *[Note: This annex is currently under development.]*

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

[227] **APPENDIX 1: Bibliography**

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

[229] **Seed as a pathway, and seed-borne and seed-transmitted diseases**

[230] **Cram, M.M. & Fraedrich, S.W.** Seed diseases and seedborne pathogens of North America (forest trees). *Tree Planters' Notes,* 53(2): 35–44. Available at http://naldc.nal.usda.gov/download/41643/PDF

[231] **Johansen, E., Edwards, M.C & Hampton, R.O.** 1994. Seed transmission of viruses: Current perspectives. *Annual Review of Phytopathology,* 32: 363–386. Available at http://www.annualreviews.org/doi/pdf/10.1146/annurev.py.32.090194.002051

[232] **Mink, G.I.** 1993. Pollen- and seed-transmitted viruses and viroids. *Annual Review of Phytopathology,* 31: 375–402. Available at http://www.annualreviews.org/doi/pdf/10.1146/annurev.py.31.090193.002111

[233] **Richardson, M.J.** 1990. *An annotated list of seed-borne diseases,* 4th edn. Bassersdorf, Switzerland, International Seed Testing Association (ISTA). Available at http://www.seedtest.org/en/productdetail---0--0--0--32.html

[234] ~~Note:~~ **ISTA** (International Seed Testing Association) "Annotated List of seed-borne diseases". An update of this list is in progress as part of the TESTA project on the basis of a full literature review with expert analysis of scientific papers. It will take the form of a database on the ISTA website (http://services.prismanet.ch/SeedDiseasesDb).

Motivation: Contextual correction and clarification

[235] **Sastry, K.S.** 2013. *Seed-borne plant virus diseases.* New Delhi, Springer Publishing.

[236] ~~Note:~~ **ISF** (International Seed Federation) Crop Pest lists are available on the ISF website (http://www.worldseed.org/isf/pest_lists.html).

Motivation: Contextual clarification.

[237] **Seed health testing and sampling protocols**

[238] **Agarwal, P.C., Mortensen, C.N. & Mathur, S.B.** 1989. *Seed-borne diseases and seed health testing of rice.* Copenhagen, Danish Government Institute of Seed Pathology for Developing Countries and Kew, CAB International Mycological Institute.

[239] **Albrechtsen, S.E.** 2005. *Testing methods for seed-transmitted viruses: Principles and protocols.* Oxford, UK, Oxford University Press.

[240] **CABI** (CAB International). 2006. *Testing methods for seed-transmitted viruses: Principles and protocols.* Wallingford, UK, CABI Publishing.

[241] **Chahal, S.S., Thakur, R.P. & Mathur, S.B.** 1994. *Seed-borne diseases and seed health testing of pearl millet.* Copenhagen, Danish Government Institute of Seed Pathology for Developing Countries.

[242] **EPPO** (European and Mediterranean Plant Protection Organization). *Diagnostic protocols for regulated pests.* Paris, EPPO. Available at http://archives.eppo.int/EPPOStandards/diagnostics.htm (accessed December 2013).

[243] **ISHI** (International Seed Health Initiative). *Manual of seed health testing methods.* Nyon, Switzerland, International Seed Federation (ISF). Available at http://www.worldseed.org/isf/ishi_vegetable.html (accessed July 2013).

[244] **ISTA** (International Seed Testing Association). 2012. *International rules for seed testing. Seed health testing methods.* Bassersdorf, Switzerland, ISTA. Available at http://www.seedtest.org/en/download-ista-seed-health-testing-methods-_content---1--1132--746.html (accessed May 2014).

ISTA (International Seed Testing Association) *International rules for seed testing, 2014, Chapter 2: Sampling.* Available at: http://www.seedtest.org/upload/cms/user/ISTA_Rules_2014_02_sampling1.pdf (accessed July 2014)

Motivation: Contextual clarification - ISTA rules are specific for seeds and provide excellent additional information on best sampling practices in addition to ISPM 31: 2009.

[245] **Mathur, S.B. & Cunfer, B.M.**, eds. 1993. *Seed-borne diseases and seed health testing of wheat.* Copenhagen, Danish Government Institute of Seed Pathology for Developing Countries.

[246] **NSHS** (National Seed Health System). *Diagnostic protocols for seed health testing.* Ames, IA, NSHS-USDA. Available at http://www.nshs.iastate.edu/Method_Stand.html (accessed January 2014).

[247] **Palacio-Bielsa, A., Cambra, M.A. & López, M.M.** 2009. PCR detection and identification of plant-pathogenic bacteria: Updated review of protocols (1989–2007). *Journal of Plant Pathology,* 91(2): 249–297.

[248] **Use of resistant varieties**

[249] **ISF** (International Seed Federation). *Plant diseases and resistance.* Nyon, Switzerland, ISF. Available at http://www.worldseed.org/isf/diseases_resistance.html (accessed December 2013).

[250] **Other**

[251] **USDA-APHIS/Iowa State University Seed Science Center.** *National seed health system.* Ames, IA, NSHS-USDA. Available at http://www.nshs.iastate.edu/#nogo (accessed May 2014).

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

[253] **APPENDIX 2: General classification of seed treatments**

[254] **1. Pesticides**

[255] Pesticides are generally used against fungi and insect pests and occasionally against bacteria and nematodes. The use of pesticides as seed treatment is regulated by national legislation and therefore authorization, formulations and concentration differ among countries and may also change over time.

[256] **2. Disinfectants**

[257] Disinfectants are generally used against bacteria and viruses. Disinfection may take place during various steps in seed processing (e.g. seed extraction, seed priming[1] or during a dedicated disinfection process. Seed disinfection can eradicate or inactivate micro-organism infestation and infection, depending on the

process and the biocide applied.

[258] **3. Physical treatments**

[259] Dry heat, steam, hot water, irradiation, (ultraviolet) light, high pressure, deep-freezing and other physical treatments are used to control bacteria, viruses, fungi and nematodes.

Seed cleaning, conditioning and sorting are used to remove soil, plant debris, *infected or suspicious seeds, weed seeds and insects.*

Motivation: Contextual clarification – seed cleaning, conditioning and sorting are also physical treatments routinely used by the seed industry during harvest and post-harvest as risk mitigation measures.

[260] **4. Biological treatments**

[261] Biological treatments are based on different modes of action, such as antagonism, competition and induced resistance. The pest may actually be on the seed at the time of planting but establishment is not possible or strongly reduced when the biological treatment is activated during germination. Biological treatments may also be used against soil-borne pests (e.g. nematodes) to create a space free from pests around the germinating seed and the root zone of the plant.

[262] **Footnote 1:** Seed priming is the pre-treatment of seeds by various methods in order to improve the seed germination rate, the percentage of germination and the uniformity of seedling emergence.