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CARIBBEAN AGRICULTURAL HEALTH & FOOD SAFETY AGENCY

CARIBBEAN DEVELOPMENT BANK

CASSAVA

GUIDELINE TO FACILITATE INTRA-REGIONAL TRADE IN THE CARIBBEAN

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REGIONAL GUIDELINES FOR
PHYTOSANITARY MEASURES

GUIDELINE TO FACILITATE INTRA-REGIONAL TRADE IN CASSAVA

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CONTENTS

Adoption

This guideline was adopted by the Council of Trade and Economic Development (COTED) in June 2022.

INTRODUCTION

Scope

This guideline provides assistance to national plant protection organisations (NPPOs) within the Caribbean region in managing the risk of introduction of specific pests associated with cross-border movement of cassava (*Manihot esculenta* Crantz) tubers intended for consumption or processing by providing clear guidance and protocols for intra-regional trade of the commodity in the Caribbean region. The guideline applies to all varieties of cassava tubers without the leaves or stem of the plant.

The major pests of cassava as well as the pests of regional priority and pests regulated by countries in the Caribbean region, and phytosanitary measures to manage these pests, are included in this guideline. General consideration is given to exclusion of general pests that affect cassava within the region. Recommended measures include those that have been adopted as International Standards for Phytosanitary Measures (ISPMs) as well as those that are used in trade amongst Caribbean countries.

This guideline does not address issues related to living modified organisms, climate change, or diversion from intended use; trade in the whole plant, cuttings, leaves or other plant parts is not covered in this document.

Definitions

Definitions of phytosanitary terms used in the present guideline can be found in ISPM 5 (*Glossary of phytosanitary terms*).

OUTLINE OF REQUIREMENTS

The issue of pest risk varies within and between countries. It is therefore important for importing NPPOs to apply pest risk analysis (PRA) (see ISPM 2: *Framework for pest risk analysis* and ISPM 11: *Pest risk analysis for quarantine pests*) in the process of identifying quarantine

pests and providing the technical justification for the implementation of phytosanitary import requirements. The importing country should consider equivalence of phytosanitary measures if the country of export is unable to conduct specific requests for phytosanitary measures. Such a process should be in keeping with ISPM 24 (*Guidelines for the determination of equivalence of phytosanitary measures*).

Phytosanitary certification and import regulatory systems should be in accordance with ISPM 7 (*Phytosanitary Certification System*), ISPM 12 (*Guidelines for Phytosanitary Certificates*) and ISPM 20 (*Guidelines for a phytosanitary import regulatory system*). Inspections and sampling of consignments should be in keeping with ISPM 23 (*Guidelines for inspection*) and ISPM 31 (*Methodologies for sampling of consignments*), respectively. Wood packaging materials, including pallets, used for consignments must be in conformance with ISPM 15 (*Regulation of Wood packaging material in international trade*).

This document seeks to provide guidance on procedures to establish phytosanitary import requirements. It also identifies and describes specific phytosanitary measures that may be used to reduce pest risk and it provides guidance on sampling, inspection and phytosanitary certification of cassava tubers for export.

BACKGROUND

Description of cassava

Cassava originated in the Neotropical Americas and is thought to have been domesticated at least 7,000 years ago. It is a perennial shrub that is grown in the tropical regions of the world, with highest production occurring in Africa, Asia and Latin America (Bellotti, 2008). The edible roots of the plant are usually cylindrical and tapered in shape and may be brown, white or reddish in color. The commodity is a common staple that is grown mainly for its starchy roots and is the fourth most important staple in the tropics.

The cassava root is considered toxic when raw and must be cooked before being consumed. There are several varieties, some of which are described bitter and some sweet. The root of the bitter variety is extremely poisonous when uncooked. All organs of the plant, with the exception of the seeds, contain cyanogenic glucosides – the compounds usually associated with the toxicity (Cereda *et al.*, 1996). The total concentration of these glucosides vary between cultivars and depends on environmental condition, cultural practices and the age of the plant.

Alves (2002) reports that juice extraction, heating, fermentation, drying, or a combination of these processes results in the reduction of free cyanide, a metabolite of cyanogenic glucoside, to safe levels for consumption.

In addition to naturally occurring cyanide, cassava can also absorb pollutants from the area of production (Warwick, 2021). Pollutants that can be absorbed include trace metal elements, pesticides, and herbicides.

The tubers have a short postharvest life as roots are highly perishable, becoming inedible 24-72 hours after harvest due to the rapid physiological deterioration process resulting from polymerization of synthesized phenolic compounds.

There are several varieties grown by cassava producers within the region, including Sugarloaf, Butterstick, Puntstick, Red Stick, Blue Stick, Maracas Black Stick, Green Stem, Pickne Moma and Guyana Sweet (CARDI Technical Bulletin Issue 5/2011).

Cassava is a major and a minor host of a range of pests, many of which are mainly associated with the above ground parts of the plant (CABI – Invasive Species Compendium: datasheet 32401). The commodity, however, has the potential to host pests that can be introduced into an importing country which could result in negative impacts on the economy.

Identity

Preferred Scientific Name
***Manihot esculenta* Crantz**
Preferred Common Name
Cassava
Other Scientific Names
***Manihot utilissima* Pohl**

Taxonomic Tree

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphyllum: Angiospermae
Class: Dicotyledonae
Order: Euphorbiales
Family: Euphorbiaceae
Genus: Manihot
Species: *Manihot esculenta*

Intended Use

The guideline covers cassava tubers for the intended purpose of consumption as food or for processing.

REQUIREMENTS

Pest risk analysis

The NPPO of the importing country should conduct PRA associated with cassava tubers in accordance with ISPM 2, *Framework for pest risk analysis* and ISPM 11, *Pest risk analysis for quarantine pests*, to determine the regulatory status of the pests for the area from which the commodity originates.

It is recommended that regional priority plant pests for the Caribbean region known to affect cassava tubers be included in the PRA. Appendices 1 and 2, respectively provide collated lists of general pests and regulated pests found on cassava grown in the Caribbean region.

Table 1 is a list of pests associated with fresh cassava tubers that may be identified as regulated pests that require phytosanitary measures by the PRA process. Measures in Table 3 are recommended for the management of these quarantine pests. These measures may be substituted where technically justified.

Table 1. Pest groups associated with fresh cassava tubers in the Caribbean region

Pest Group	Family	Example species
Ants	Formicidae	*Acromyrmex octospinosus* (Reich) *Atta cephalotes* (Linnaeus) *Atta sexdens* (Linnaeus)
Beetles	Chrysomelidae	*Diabrotica balteata* (LeConte)
Fruitflies	Tephritidae	*Anastrepha striata* (Schiner)
Mealybugs	Pseudococcidae	*Paracoccus marginatus* Williams & Granara de Willink, 1992
Moths	Noctuidae	*Spodoptera litura* (Fabricius)

In the conduct of the pest risk assessment, significant uncertainty may be identified, making it difficult to evaluate phytosanitary measures. Cases of uncertainty do not mandate the

application of measures unless it is determined that a pest is likely to be introduced and result in negative economic impacts in the PRA area.

In Table 2, a list of pests for which there is uncertainty in the Caribbean as to association with cassava tubers in trade is included as well as a description of the uncertainty.

Table 2. Pests with uncertain association with cassava tubers in trade

Pest Group	Family	Pest	Description
Phytomo-nads	Trypanosomatidae	*Phytomonas* spp.	No information is yet available on whether these pests are present in the region or would follow the pathway of cassava tubers moving in trade.
Viroids	Alphaflexiviridae	Cassava New Alphaflexivirus (CsNAV) Cassava Polero-Like virus (CsPLV) Cassava Torrado-Like Virus (CsTLV)	Although *Bemisia* spp. – primary vectors of these viroids and viruses - are present in the region, it is uncertain as to whether the pathway of cassava tubers moving in trade in the region were these pathogens to be determined to be present.
Viruses	Gemiviridae	Cassava African Mosaic Virus East African Cassava Mosaic Virus Indian Cassava Mosaic Virus	
	Potyviridae	Cassava Brown Streak Virus	
	Alphaflexiviridae	Cassava Common Mosaic Virus	

General Procedures

Once technically justified, general procedures include the following:

Production

- Registration of producers, farms and exporters and maintenance of a registry of these entities by the NPPO of the exporting country
- Application of good agricultural practices (GAP) (e.g., site and land selection, use of pest resistant or tolerant varieties where available, farm sanitation, weed management)
- Avoiding flood prone production areas
- Monitoring for pests, particularly regulated soil-borne pests

Packaging and grading

- Registration of packing houses
- Development of, and compliance with, packing house requirements
- Pest management in the packing house

- Packing in new and clean material (including protective material, where required)
- Labelling of packaging
- Storage prior to export and transportation in a secure manner to prevent contamination and infestation (e.g., use of insect-proof packaging)
- Grading (guided by CODEX standards[1]) to ensure suitability of tubers for export, including freedom from damage, symptoms of pests and contamination with soil, plant debris and extraneous materials

Treatment facilities

- Registration and approval of treatment facilities (when different to the packing house) in accordance with established procedures
- Secure management to prevent contamination and infestation.

Sanitary (Food Safety) Measures

Food contamination can be caused in several ways, the main types of which are biological, chemical, physical and allergenic. Some such contamination could be due to naturally occurring contaminants in the environment or artificially introduced by certain agricultural practices. Food contamination is a matter of serious food safety concern because high concentrations of chemicals and contaminants present in food can pose serious health risks.

Cassava should be grown in soils that are low in heavy metals and other contaminants that may be absorbed by the tubers during the production period. Cassava varieties that are low in levels of cyanogenic glucosides are recommended for production of tubers for consumption due to associated toxicity if consumed when improperly cooked.

The handling, packaging, transporting and storage of commodities intended for consumption are significant contributors to food contamination. It is therefore important that good agricultural practices and good hygiene practices are maintained from the point of production to the point of export to reduce or eliminate contamination of consignments of cassava tubers. All surfaces or equipment intended to touch the produce must be cleaned and sanitized at a frequency sufficient to prevent the surfaces from becoming a source of contamination. Chemical treatments must be approved for use on these commodities and should be applied

[1] CODEX Alimentarius “Fresh Fruits and Vegetables”. https://fao.org/3/a1389e/a1389e00.htm

strictly in accordance with the manufacturer's recommendations on the label and in keeping with maximum residue levels (MRLs) as prescribed by the suitable authority. Fresh cassava can be preserved using thiabendazole or bleach as a fungicide, followed by wrapping in plastic, coating in wax or freezing. Waxes used for tuber preservation must be approved food grade products.

Persons handling cassava in production and after harvest should be (made) aware of proper personal hygiene and apply good hygienic practices at all times.

Record keeping is fundamental for a proper traceability system. Information to be recorded would include, but not be limited to, employee training, environmental assessments, water usage, pest control, production practices, and the source of all agricultural inputs used in the production of the cassava crops.

Phytosanitary Measures

Table 3 below provides information on pests associated with cassava tubers along with measures considered to be effective in managing each pest group previously identified in Table 1.

Table 3. Phytosanitary measures considered to be effective in managing the risk from specified pest groups

Pest Group	Phytosanitary Measure(s)
Ants	PFA[2], PFPP[3], systems approach
Beetles	Harvest management, post-harvest brushing, visual examination, exclusion of soil to eliminate eggs and pupae
Fruitflies	PFA, brushing to exclude soil and remove puparia, fumigation
Mealybugs	Harvest management, post-harvest brushing, visual examination
Moths	PFA, PFPP, systems approach

NPPOs of importing countries in the region should recognize the effectiveness of treatments demonstrated by the exporting country to manage the target pests or provide technical justification in support of alternative measures. Phytosanitary measures applied to manage the risk(s) from one pest could likely also manage the risks posed by other pests of the commodity.

In the case of phytosanitary import requirements, such should be required solely for pests that countries have identified as regulated pests that require the application of phytosanitary measures thus determined by PRA for the endangered area. In cases where the association of

[2] Pest Free Area
[3] Pest Free Places of Production

the pest or pest group to the pathway is uncertain, phytosanitary measures should be justified through PRA.

Pest Free Areas (PFA)

Guidance on pest free areas may be sourced in ISPM 4 (*Requirements for the establishment of pest free areas*) and ISPM 8 (*Determination of pest status in an area*).

Pest Free Places of Production (PFPP) and Areas of Low Pest Prevalence (ALPP)

Guidance on pest free places of production and areas of low pest prevalence is found in ISPM 10 (*Requirements for the establishment of pest free places of production and pest free production sites*) and ISPM 22 (*Requirements for the establishment of areas of low pest prevalence*). The utility of these phytosanitary measures may be limited by some characteristics of pests.

Pre-harvest and Harvest Management

Pre-harvest management

Pre-harvest pest management programmes, such as use of chemical, biological and cultural control methods, to reduce the incidence of pests of cassava tubers, and the removal of infested tubers at harvest comprise good handling and cultural practices to be used in both the production and marketing of cassava tubers.

Harvesting

Care being taken to reduce bruising and damage to cassava tubers at harvest is also quite important in reducing deterioration and opportunistic infection of the commodity. Upon harvesting, tubers should be packed carefully, preferably in plastic crates, taking care not to overfill the crates and transported to the packinghouse.

Post-harvest handling and treatments

Handling and sorting

Harvested produce should always be cooled before they are packed. Damaged tubers should be separated from undamaged ones, the latter of which should be stored in crates, rather than

feed bags, and covered with a moist breathable material. Each load should be stowed stably and be kept well ventilated. Packages should be strong enough to protect the contents and should not be stacked higher than the maximum recommended to prevent collapse under the weight above. Packages should be loaded on dunnage or pallets on the beds of transport vehicles to allow for circulation of air around the stacks.

Transportation

Vehicles used to transport cassava tubers should be clean and provide a cool environment for the produce, and records should be kept of all vehicular cleaning activities. Every effort should be made to prevent damage to the produce while being loaded, transported and off-loaded, regardless of the method of transport being used to move the goods.

Cleaning

Pests that are likely to be removed from the tubers by brushing include mealybugs and surface contaminating pathogens. A soft-bristled brush can be used to gently scrub the tubers in a trough of fresh, clean cold water to remove attached soil and foreign matter. Any water used in the cleaning process should be of a potable quality.

Storage

Cassava tubers can deteriorate rapidly after harvesting due to mechanical damage or to a physiological deterioration that causes blue-black vascular streaking. This disorder greatly reduces the palatability and marketability of tubers within 2-4 days of harvesting. Dehydration of the tubers and reducing the presence of high oxygen levels can help to reduce the disorder. Storage of tubers at 10ºC and 80% relative humidity can significantly delay the onset of deterioration of cassava tubers after harvest.

Packinghouse inspection

The above-stated post-harvest actions should be supported by inspection of the commodity in the packinghouse to determine their effectiveness at pest removal. Tubers found to be infested during the process should be discarded or appropriate remedial actions applied.

Treatments

Treatments include a range of processes that are targeted at the control or eradication of pests and contaminants from approved commodities, empty containers and export vessels. Treatments can include – but are not limited to – fumigation; irradiation; use of controlled

atmosphere or temperature; application of a chemical substance; dismantling, repairing or cleaning; repacking; or blending. The choice of the treatment applied is the responsibility of the importing country, unless otherwise determined by legislation or international standards. The process of treatments should be guided by ISPM 28 (*Phytosanitary treatments for regulated pests*).

Specific treatments for cassava tubers may be selected and mutually agreed upon between the countries of import and export in accordance with approved international standards and treatments, or where bilaterally agreed.

Irradiation

Treatments for the use of ionizing radiation (irradiation) may be used for pest risk management. Phytosanitary irradiation is a treatment which uses ionizing radiation on commodities such as fruits and vegetables to inactivate pests. The method is used for international food trade as a means to prevent spread of non-native organisms. NPPOs should be assured that the efficacy of the treatment is scientifically demonstrated for the regulated pest(s) of concern and the required response. The application of irradiation as a phytosanitary treatment should be in accordance with ISPM 18 (*Guidelines for the use of irradiation as a phytosanitary measure*). ISPM 28 Annex 7 (*Irradiation treatment for fruit flies of the family Tephritidae [generic]*) would be a guide for treatment for tephritid fruitflies in cassava trade.

Waxing and High Relative Humidity Storage

Cassava tubers may be waxed using established industry procedures or sealed in polythene bags and stored. These procedures will help to prolong the shelf life of the tubers.

Fumigation treatment

Fumigation is the treatment with a chemical agent that reaches the commodity and target pest(s) in a gaseous state. The fumigant may be effective against all pest groups or used to target a particular pest group and may address all or most life stages. The application of fumigation as a phytosanitary treatment should be in accordance with ISPM 43 (*Requirements for the use of fumigation as a phytosanitary measure*). Scientific data to support effective fumigation treatment for Tephritidae fruit flies on cassava is not currently available.

Storage facilities, both on- and off-farm, should be approved and outfitted with the required cool stores and warehousing facilities linked to postharvest crop management. Fumigation

should only be done when necessary and only by a licensed or trained operator. All fumigation instances, chemical agents used, and dates of application should be documented.

Chemical treatment

Chemical treatments are used on a wide range of agricultural products from pre-planting through to post-harvest stages. These treatments are intended to destroy, repel and control pests of agricultural commodities. The chemicals are commonly applied by dipping (i.e., fully immersing the commodity into a solution) or spraying at a specific concentration for a specified period, to reduce the risk of a broad range of pests in the target area or on the target commodity. Chemical treatments may also be used to destroy pests within empty holds of a vessel or container.

After cleaning, cassava tubers should be allowed to drip dry in a clean area for 10-15 minutes. The tubers may then be sanitized to destroy possible soil borne pests using a chlorine dip (10 ppm for 10 minutes). Alternatively, the crates may be immersed in a fungicide and surfactant solution prepared in keeping with product recommendations. This will help to kill any pathogens and other contaminants on the tubers. The commodity is to be allowed to dry after removal from the solution. Cassava tubers may be subjected to an importing NPPO-approved chemical treatment where necessary.

Temperature treatment

Temperature treatments may be used as a phytosanitary treatment option. The application of heat treatments and systems to support the treatments should be in accordance with ISPM 42 (*Requirements for the use of temperature treatments as phytosanitary measures*) and technically justified by PRA.

Vapour Heat Treatment (VHT) is the process in which water vapours are used to heat a commodity until it reaches a minimum temperature for a specified period of time to effectively control live infestations of certain pests. It is an option generally used for commodities that are resistant to high moisture and vulnerable to drying out.

Cold treatment involves the use of refrigerated air to lower the temperature of a product to, or below, a specific temperature for a specific period to mitigate the risks of infestations of target pests. This treatment is used primarily for fresh fruits and vegetables that are hosts of internally feeding pests. The treatment is generally commodity and pest specific.

Packing, packaging and labelling

Packaging is a pivotal step in the journey of fresh produce from the farm to the table, and a number of options is available depending on the specifications of individual consignments (NC State Extension Publications, 1996). The packaging materials of shipping cartons should be free of any toxic chemicals.

A label to be affixed to each carton/container should clearly detail the name of the commodity and other relevant information, including but not limited to: the variety, the farmer's registration number, the name and address of the exporter, the harvest date, the packing date, the gross weight or net weight, and the names of the grower and the processor/exporter. Any other quantitative information should be also included on the label in keeping with the importing country's requirements.

Transportation

In the transportation of cassava tubers for consumption, all applicable handling, packaging and storage procedures must serve to prevent damage to the produce and proliferation of pests during the process. Closed trucks used to transport the tubers should be suitably retrofitted to allow for ventilation of the produce. Ventilation of long-distance vehicles should be done by fitting the vehicle with air intakes and louvres to allow for a positive air flow through the load. During the shipping process, cassava tubers should not be placed in areas with extreme temperatures. The cartons should not be dropped, thrown, packed in inverted position, rolled or tipped. Regardless of the means of transport, the produce must be kept dry and at optimal temperatures and should be moved to market as quickly as possible.

Systems Approaches

Guidance for the use in development and evaluation of integrated measures in a systems approach can be found in ISPM 14 (*The use of integrated measures in a systems approach for pest risk management*). At least two measures which are independent of each other may be used to manage specific quarantine pests and any uncertainty.

Verification of compliance

Sampling and inspection should be carried out to verify compliance of consignments of cassava tubers with phytosanitary import requirements.

The NPPO may authorize entities to conduct specific phytosanitary activities (e.g., sampling, inspection and testing in accordance with the ISPM 45 (*Requirements for national plant protection organizations if authorizing entities to perform phytosanitary actions*).

Sampling and phytosanitary inspection

ISPM 31 (*Methodologies for sampling of consignments*) and ISPM 23 (*Guidelines for Inspection*) may be used for official guidance on sampling and phytosanitary inspection.

In accordance with official procedures, the NPPO of the exporting country should sample and inspect each consignment of cassava tubers to verify conformance with importing requirements and freedom from quarantine pests. If infield controls require the registration of the production area or farm(s), sampling and inspection should be conducted in each homogenous grower lot.

If infield controls require the registration of the production area or farm(s), sampling and inspection should be conducted in each homogenous grower lot. In instances where live pests are found, the exporting country NPPO should determine whether additional actions are required to meet the conditions of the importing country NPPO.

The number of packages presented for inspection should be consistent with documentation for the consignment. The documentation should certify that basic measures have been applied and that any required traceability labelling is complete. Initial inspection of the consignment should also verify that the phytosanitary security is maintained for the consignment.

Minimum sample size for inspection should be based on a 95% confidence level as set out in ISPM 31 (*Methodologies for sampling of consignments*), or as specified by the NPPO of the importing country with technical justification.

Phytosanitary certification

All commodities intended for export attain a phytosanitary status when they are produced in a PFA or PFPP; after harvest, for commodities from certified farms required to eliminate, manage or monitor specific pests; after a phytosanitary treatment, and after export inspection. A phytosanitary certificate should only be issued when the requirements of the importing country, as set out in an Import Permit issued by its NPPO, have been verified as being met as confirmed

in the certifying statement. Phytosanitary certification (for export and re-export) should be in keeping with ISPM 12 (*Phytosanitary certificates*).

An additional declaration may be required by the country of import to verify compliance with the import requirements as specified by the importing country's NPPO.

For consignments of cassava tubers for consumption to receive phytosanitary certification, the consignments must:

- Meet the specific requirements as indicated in the Import Permit issued by the importing country
- Originate only from officially approved places of production
- Be clean (i.e., practically free from viable regulated pests, and associated tissue damage, soil, chemical contaminants, or any other extraneous material and substances)
- Be treated in a manner consistent with the application standard and treatment certificate presented
- Be accompanied by pest free area declaration, where required
- Be packaged in clean and either new or refurbished material
- Be exported in a secure manner to prevent contamination.

Cassava tubers must be intact and clean, and free from rot, visible foreign matter and damage caused by pests. If viable regulated pests are detected, a phytosanitary certificate should not be issued unless appropriate phytosanitary measures have been applied.

If a consignment of cassava tubers is opened, split up or packaging changed prior to arriving in the country of import, a phytosanitary certificate for re-export is required from the re-exporting country. Re-exported consignments must be accompanied by (a copy of) the original phytosanitary certificate.

Phytosanitary certificates, and Phytosanitary Certificates for Re-export should be in accordance with ISPM 12 (*Phytosanitary certificates*).

Phytosanitary security

Once commodities have received phytosanitary certification, and until such commodities are exported, the phytosanitary security of the commodities must be maintained at all times. As such, the commodities must be adequately protected to prevent infestation or contamination and labelled (in keeping with the legislation and importing country requirements) to prevent

substitution. Breaches of security during transport or storage disqualifies the phytosanitary status of the commodities.

Phytosanitary security is maintained:

1. when secure packaging (cartons, pallets) is used and/or
2. the consignment is isolated by physical barriers, distance or insect-proof space), AND
3. appropriate measures are taken while loading export containers.

Secure packaging

Secure packaging requirements could comprise of the following:

Container level security

- The commodity is fully enclosed in a container with the lids tightly fixed to the base
- Ventilation holes or other openings are covered with insect-proof mesh that has no more than a 1.6mm diameter pore size diagonally; alternatively, ventilation holes are fully sealed.
- Vented containers having plastic liners or bags must be fully sealed. The overlapping folded edges of the plastic liner with the container lid on top would be considered fully sealed.

Pallet level security

For cartons that are palletized, security would be achieved using one of the following options:

- Each pallet is fully shrink-wrapped, with the base and the top of the pallet sealed (e.g., using a sheet of cardboard), as well as all sides, to completely enclose the commodity consignment.
- Each pallet is secured with insect-proof mesh using a pallet net with no more than a 1.6 mm pore size diagonally, to include the surface area between the bottom row of the cartons and the pallet.

Isolation requirements

Commodities that are not secure-packaged may be kept secure if they are isolated from all potential sources of infestation or contamination and from other goods of different or unknown phytosanitary status.

Isolation by physical barriers

Physical barriers (e.g., walls or solid structures) can be used to exclude pest access. This option can be applied when the commodities are stored and handled in insect-proof spaces, shipping containers, enclosed vans or cool rooms.

Isolation by distance

The phytosanitary status of consignments may be maintained by creating a minimal acceptable distance between goods of different or unknown phytosanitary status within insect-proof spaces. This can be achieved if goods are kept at optimal temperatures for the commodity and with at least 1m separation from any other goods.

Isolation by insect-proof spaces

The phytosanitary security of a consignment can be maintained if, at all times, the goods are kept in insect-proof spaces and are kept isolated from all potential sources of infestation or contaminants, to include products of different or unknown phytosanitary status. Pack houses, treatment facilities and cool room storage doors must be suitably insect-proof through the use of double doors, automatic doors, rubber curtains, air curtains or other approved mechanism.

Loading procedures

During the loading process, it is important to maintain phytosanitary security of the consignment by ensuring the following occurs:

- Containers with vent holes and openings must be sealed, with openings no more than 1.6 mm pore size diagonally (e.g., drain holes or air intakes)
- Consignments must be loaded directly into the export container
- Commodities not securely packaged and not immediately loaded must be stored securely to prevent contamination or infestation
- Personnel loading export containers must ensure that the consignments are moved from the secured area into the export containers as quickly as possible
- Consignments must not be left unsecured and loading procedures must mitigate potential infestation.

One or more methods should be applied to safeguard cassava tubers against infestation after the application of a phytosanitary measure. Such methods should take into account the biological characteristics of pests and the strength of the phytosanitary measures that have been applied.

Consignments in transit

In the movement of regulated commodities within the Caribbean, such commodities may transit various countries *en route* to the country of import. Procedures to identify, assess and manage pest risks associated with consignments of these commodities which pass through a country without being imported, should be conducted in such a manner that any phytosanitary measures applied in the country of transit are technically justified and necessary to prevent the introduction into and/or spread of pests within that country. ISPM 25 (*Consignments in transit*) provides guidance for handling of consignments in transit.

Audit and compliance of the export pathway

In keeping with ISPM 20 (*Guidelines for a phytosanitary import regulatory system*), the importing country's NPPO may request an audit of specific elements of the cassava tuber export system. This could relate to entities registered/approved to export as well as the records relating to exported consignments. Verification of compliance of the consignment may be sought by the importing country in the country of export.

REFERENCES

This guideline 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

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APPENDICES

APPENDIX 1. List of pests found on cassava in the Caribbean region

[source: National Plant Protection Organizations of Member States]

Pest Type	Scientific name	Common name(s)
Bacterium	*Erwinia carotovora subsp. carotovora* (Jones)	Bacterial root rot of sweet potato
Bacterium	*Erwinia chrysanthemi*	Bacterial soft rot
Bacterium	*Ralstonia solanacearum*	Bacterial wilt
Bacterium	*Thanatephorus cucumeris (*Frank*)*	Leaf spot, sharp eyespot etc.
Bacterium	*Xanthomonas axonopodis (campestris)* pv. *manihotis*	Cassava bacterial blight
Bacterium	*Xanthomonas campestris pv. citri*	Leaf scorch
Fungus	*Alternaria* spp.	Alternaria leaf spot, Leaf & stem blight
Fungus	*Asterina manihotis*	leaf mold
Fungus	*Athelia rolfsii*	sclerotium rot
Fungus	*Ceratocystis fimbriata*	Black rot
Fungus	*Cercospora caribaea*	White leaf spot of cassava
Fungus	*Cercospora henningsii* Allesch	Brown Leaf spot
Fungus	*Corticium rolfsii (*Sacc.)	Sclerotium rot
Fungus	*Diaporthe manihotis*	Cassava leaf spot
Fungus	*Elsinoë brasiliensis*	superelongation disease of cassava
Fungus	*Fusarium oxysporum*	basal rot
Fungus	*Fusarium solani*	Fusarium root and stem rot
Fungus	*Glomerella cingulata* (Stonem.) Spauld & Schrenk	Anthracnose
Fungus	*Lasiodiplodia theobromae*	diplodia pod rot of cocoa
Fungus	*Leptospharea illudens* Drake	Leptospharea leaf spot
Fungus	*Macrophomina phaseolina*	charcoal rot of bean/tobacco
Fungus	*Mycosphaerella henningsii*	Brown leaf spot of cassava
Fungus	*Passalora manihotis* (*Cercospora caribaea*)	white leaf spot of cassava
Fungus	*Rhizoctonia solani* (*Thanatephorus cucumeris*)	Collar rot of bean
Fungus	*Rosellinia bunodes* (Berk)	Black root rot
Insect	*Aleurodicus dispersus*	Spiralling whitefly
Insect	*Aonidomytilus (Lepidosaphes) albus* Cockerell	Tapioca (cassava) scale
Insect	*Atherigona orientalis* (Schiner)	Pepper fruit fly
Insect	*Bemisia tabaci* (B biotype)	Silverleaf whitefly
Insect	*Bemisia tabaci* (Gennadius)	Tobacco whitefly
Insect	*Ceroplastes cirripediformis* (Comstock)	Barnacle scale
Insect	*Clavaspis herculeana* (Cockerell & Hadden)	Herculeana scale
Insect	*Coccus viridis* (Green)	Soft green scale
Insect	*Coelosternus* sp.	Cassava stem weevils
Insect	*Corcyra cephalonica*	rice meal moth
Insect	*Corynethrips stenopterus* Williams	Cassava thrips
Insect	Cory*thuca gossypii* (Fabricius)	Cotton lacebug, bean lacebug
Insect	*Crypticerya genistae*	White scale
Insect	*Diaprepes abbreviatus* (L.)	Citrus root weevil
Insect	*Dysmicoccus brevipes* (Cockerell)	Pineapple mealybug
Insect	*Ecyrus hirtipes* Gahan	Longhorn borer beetle

Pest Type	Scientific name	Common name(s)
Insect	*Edessa meditabunda* (Fabricius)	Green and brown stink bug
Insect	*Erinnyis alope*	papaya hornworm
Insect	*Erinnyis ello* (L)	Cassava hornworm
Insect	*Feltia subterranea* (Fabricius)	Granulate cutworm
Insect	*Ferrisia virgata* (White)	Striped mealybug
Insect	*Frankliniella melanommata* Williams	Common thrip
Insect	*Heliothrips haemorrhoidalis*	black tea thrips
Insect	*Lagocheirus araneiformis* (Linnaeus)	Long horn beetle
Insect	*Latrophobia braziliensis* (Rubs)	Cassava leaf-gall midge
Insect	*Leptopharsa illudens* Drake	Cassava lacewing bug
Insect	*Lonchaea chalybea* Wied	Lonchaeid fly
Insect	*Maconellicoccus hirsutus* (Green)	Pink hibiscus mealybug
Insect	*Metamasius hemipterus* (L.)	West Indian cane weevil
Insect	*Neosilba pendula (Silba chalybea)*	*Cassava shoot fly*
Insect	*Neosilba perezi*	Cassava shoot fly
Insect	*Nezara viridula* (L.)	Green stink bug
Insect	*Nipaecoccus nipae* (Maskell)	Spiked mealybug
Insect	*Omphisa anastomosalis*	Sweet Potato stem borer
Insect	*Paracoccus marginatus* (Williams and Granara de Willink)	Papaya mealybug
Insect	*Phenacoccus gossypii*	mexican mealybug
Insect	*Phenacoccus madeirensis* (Green)	Cassava mealybug, Madeira mealybug
Insect	*Phenacoccus manihoti* Matile-Ferrero	Cassava mealybug
Insect	*Pinnaspis strachani* (Cockerell)	Lesser snow scale
Insect	*Planococcus citri* (Risso)	Citrus mealybug
Insect	*Pseudaulacaspis pentagona* (Targ.) *albus* Ckll.	Mulberry scale
Insect	*Pseudococcus elisae*	banana mealybug
Insect	*Pseudococcus jackbeardsleyi*	Jack Beardsley mealybug
Insect	*Pseudococcus longispinus* (Targioni Tozzetti)	Long-tailed mealybug
Insect	*Saissetia coffeae (hemisphaerica)* (Targ)	Hemispherical scale
Insect	*Saissetia coffeae* (Olivier)	Hemispherical scale
Insect	*Saissetia miranda (Cockerell)*	Mexican black scale
Insect	*Scirtothrips dorsalis*	chilli thrips
Insect	*Silba chalybea*	Cassava shoot fly
Insect	*Spodoptera eridania*	southern armyworm
Insect	*Stegobium paniceum*	drugstore beetle
Insect	*Systena s-littera*	Potato beetle
Insect	*Thrips tabaci* (Gennadius)	Potato thrips, onion thrips
Insect	*Tribolium castaneum*	red flour beetle
Insect	*Vatiga illudens* (Drake)	Cassava lace-wing bug
Mite	-	*Cassava Mites (?)*
Mite	*Mononychellus caribbeanae*	Cassava green mite
Mite	*Mononychellus tanajoa* (Bonda)	Cassava green mite
Mite	*Tetranychus marianae*	Tropical red spider mite
Mite	*Tetranychus sp.*	Spider Mites
Mite	*Tetranychus urticae (telerius)* (Koch)	Red spider mite
Nematode	*Helicotylenchus dihystera*	Common spiral nematode
Nematode	*Helicotylenchus multicinctus*	Banana spiral nematode
Nematode	*Hemicriconemoides mangiferae* (Siddiqi)	Sheathoid nematode
Nematode	*Meloidogyne incognita*	Root knot nematode
Nematode	*Rotylenchulus reniformis* (Linford & Oliviera)	Reniform nematode

Pest Type	Scientific name	Common name(s)
Oomycete	*Phytophthora palmivora* (Buttler)	Coconut budrot
Oomycete	*Phytophthora* sp.	Root rot
Weed	*Acanthospermum hispidum* (Candolle)	Bristly starbur
Weed	*Ageratum conyzoides* (L.)	Billy goat weed
Weed	*Commelina benghalensis* (L.)	Wandering jew
Weed	*Datura stramonium* (L.)	Jimsonweed
Weed	*Emilia sonchifolia* (L.)	Red tasselflower
Weed	*Momordica charantia* (L.)	Bitter gourd
Weed	*Senna obtusifolia* (L)	Sicklepod
Weed	*Solanum torvum* (Schwartz))	Turkey berry
Weed	*Stachytarpheta jamaicensis* (L)	Jamaica vervain
Weed	*Synedrella nodiflora* (synedrella)	Nodeweed, Cinderella weed

APPENDIX 2. List of pests of cassava regulated by countries in the Caribbean region

[Source: National Plant Protection Organisations of Member States]

Pest Type	Scientific name	Common name(s)
Bacterium	*Xanthomonas axonopodis pv.manihotis*	Bacterial Blight
Insect	*Acromyrmex octospinosus* (Reich)	Leaf cutting ant
	Anastrepha striata (Schiner)	Guava fruit fly
	Atta cephalotes (Linnaeus)	Bachac/Umbrella ant
	Atta sexdens (Linnaeus)	Acoushi ant
	Diabrotica balteata (leconte)	Banded cucumber beetle
	Paracoccus marginatus Williams & Granara de Willink, 1992	Papaya Mealy bug
	Phenacoccus manihoti (Matile-Ferrero)	Cassava mealybug
	Sitophilus oryzae (Linnaeus)	Rice weevil
	Spodoptera litura (Fabricius)	Cluster caterpillar
	Trialeurodes abutilonea Haldeman	Bandedwinged whitefly
Mite	*Tetranychus cinnabarinus* (Boisduval)	Carmine spider mite
	Tetranychus desertorum Banks	Desert spider mite
Mollusc	*Veronicella cubensis* (Pfeiffer)	Two-striped slug
Phytomonad	*Phytomonas* spp.	
Viroid	Cassava New Alphaflexivirus (CsNAV)	Cassava Frogskin disease (CFSD)
	Cassava Polero-Like virus (CsPLV)	Cassava Frogskin disease (CFSD)
	Cassava Torrado-Like Virus (CsTLV)	Cassava Frogskin disease (CFSD)
Virus	African cassava mosaic virus (Begomovirus)	African cassava mosaic virus
	Cassava African Mosaic Virus	Cassava African mosaic virus
	Cassava Brown Streak Virus	Cassava brown streak virus
	Cassava Common Mosaic Virus	Cassava common mosaic virus
	Cassava Latent virus	Cassava latent virus
	Cassava mosaic geminiviruses	Cassava mosaic geminiviruses
	East African cassava mosaic Camerun geminivirus	
	East African cassava mosaic geminivirus	
	East African cassava mosaic Malawi geminivirus	
	East African cassava mosaic Zanzibar geminivirus	
	Indian cassava mosaic geminivirus	