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SIAEP

STANDARD OPERATING PROCEDURES

For Transportation For Export Mangoes

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Acronyms

CA	Controlled Atmosphere
CFM	Cubic feet/minute
CMS	m ³ /s
DC	Distribution Center
ISPM 15	International Standards for Phytosanitary Measures No. 15
HDPE	High Density Polyethylene Plastic
PE	Polyethylene Plastic
PP	Polypropylene Plastic
VHT	Vapor Heat Treatment
SOPs	Standard Operating Procedures
SWL	Safe Working Load
UV	Ultra Violet

1. Scope of SOP Document

This document aims to establish guidelines for the operation process of exporting mangoes. The purpose is to prevent damage to the mangoes during transportation and to ensure that they meet the quality requirements of modern retail systems.

This document can be used as training and reference resources for Agricultural Extension Centers, Vietnam Fruit and Vegetable Association, or agricultural students at Universities and Colleges.

2. Key Definitions

ISPM 15 is an international standard that regulates the movement of wooden packaging and dunnage through international trade and aims to prevent the global spread of harmful pests on wood.

3. Introduction

This document supports transporters in meeting the requirements of the export market. This helps provide consistent quality fruit that meets the technical specifications and standards of the product, while meeting expectations for shelf life and complying with all regulations, health, safety, and environmental standards.

This document applies to mango businesses and individuals involved in the mango export chain, such as transporters, producers, farm managers, agricultural officials, buyers, packers, service providers, and exporters.

condition certification programs, organic products).

This document is intended to be read with in conjunction with the following SOP documents:

- SOP No.1 Standard Operating Procedures for exported mangoes field practices
- SOP No.3 Standard Operating Procedures for disease management of exported mangoes

- SOP No.4 Standard Operating Procedures for cool chain management of exported mangoes
- SOP No.5 Standard Operating Procedures for transportation of exported mangoes
- SOP No.6 Standard Operating Procedures for traceability of exported mangoes
- SOP No.7 Standard Operating Procedures for mangoes export market requirements manual

4. Principles of SOP

Principle 1: Packaging, Transportation Method and Load Management

This influences all factors along the mango supply chain, such as abrasion, contamination, heat transfer, damage due to compression, and the ability to cool, which will ultimately affect fruit shelf life and the presentation of the fruit at retail. All of these factors are cumulative over time and distance.

Principle 2: Temperature Management

At all points along the chain, this has a cumulative impact on the shelf life of the fruit and the ability to export it over long distances. This is through influencing the rate of fruit ripening, disease development, fruit respiration and dehydration.

Principle 3: Export System

Each export transportation system by air, road, and sea has specific requirements and procedures that must be followed to maximize export quality at the destination market.

Principle 4: Compliance and Record Keeping

Verification that management practices meet standards, regulations, quality, environmental, health, and safety requirements.

5. Packaging and Shipping Management.

5.1. Basket Storage at the Orchard

5.1.1. Types of Baskets General Specifications

For export, only plastic baskets should be used, do not use wooden crates or bamboo baskets. Dynamic load (lifting, transport, stacking): 30-50kg, static load (stacking): 150kg; material: HDPE/PP plastic, UV stable. The crates must have good ventilation holes on all sides to allow the fruit to dry quickly. The inside of the crate must be smooth and without any protrusions.

(Refer to the size specifications of some types of baskets in the Mango Export Packaging Management - SOP 2).

5.1.2. Shipping, Stacking, and Cleaning

Ensure that the crates are clean before placing the fruit in them. If the fruit still has the stem, it should be carefully placed in the crate to avoid breaking it. Fruit with broken stems should be put in a separate basket. Do not load wet fruit into the crate (unless the fruit has been thru desapping treatment). When placing the mangoes in the basket, handle them gently to avoid bruising or internal damage. Do not fill the crate above the lip, as this will lead to compression damage to the fruit.

When packing mango crates, workers must adhere to the specified load limit for each type of crate. This will ensure the safety of workers and prevent the mangoes from being crushed. The maximum stack height should not exceed 5 crates. Stacked crates should be kept in the shade to avoid direct sunlight. If this is not possible, a clean cloth should be placed over the baskets. The crates should be cleaned with water and detergent to remove latex and dirt after each use and dried before reuse. Dirty baskets should not be used until they have been cleaned.

5.2. Transport from the Orchard to the Packing House

5.2.1. Means of Transport

Motorbikes

This is not recommended for transporting export mangoes, however it can be still used if alternatives are available. It is necessary to ensure that the motorcycle operates well with proper license, registration and good functional shock absorbers. The load must be evenly distributed on the vehicle and the mango crates must be carefully tied. Make sure the mango crates are protected from the sunlight and dust. Do not transport when the fruits are wet. It is advisable to drive slowly and avoid bumpy roads, and to transport fruits during cooler times of the day

Three-wheeled Vehicles

The three-wheeled vehicle is a suitable means of transporting fruit from the orchard to the packaging house providing greater stability compared to motorbike. Ensure vehicle is in good working condition with appropriate licensing, registrations and has good functional shock absorbers. The load should be evenly distributed on the vehicle and carefully secured to prevent overloading. The mango crates must be protected from direct sunlight and dust. It should not be transported in wet conditions or during rain. The vehicle should be driven slowly and avoid rough roads, and fruits should be transported during cooler times of the day.



Small Truck

A small truck is an ideal option for transporting fruit from the orchard to the packaging house. The truck must have a covering to protect the fruit from direct

sunlight and dust, and should be operated with a proper license and registration, as well as stable brake function.

5.2.2. Loading Vehicles

The crates must be carefully stacked to avoid unnecessary impact. Ensure crates are not over filled and fruit is not higher than the height lip of the crate. If the fruits still have stems, make sure that no stems protrude from the top of the crate. If the route to the packhouse is not a paved road, the crates must be covered with a tarpaulin to minimize dust pollution. The transport vehicle needs to be covered to protect the top layer of the fruit from direct sunlight during transportation. Make sure the load is evenly distributed on the vehicle.

When delivered to the packhouse, the mangoes will be carefully stacked on specialized pallets. The mango crates must be placed not dropped or thrown when unloading.

5.3. Packhouse

5.3.1. Packaging

The mango packhouse is a combination of the workshop and the machinery, equipment, personnel, and support processes to convert the fruit from the harvesting stage into market-ready products.

Mangoes are packed by hand in cartons, with two-part boxes preferred for air travel and open-top single-part boxes suitable for sea transportation.

The cartons used for packaging must be fit for purpose for the transportation system to be used, with strength, moisture resistance, fruit protection, and good ventilation. The carton must be able to withstand the weight of palletizing and transporting, under high humidity conditions. With a load-bearing capacity of about 17.5-19.3 kg/cm².

The standard carton size for exporting mangoes is 420x310x120mm (for the US market), 500x335x120mm (for Europe), and 480x325x120mm (for Japan and South Korea). These sizes are not a regulatory requirement and will vary according

to importing markets requirements. It is important the footprint of the carton matches the size pallet that is going to be used for export.

The cartons must be tightly packed to prevent the fruit from moving during transport. In some cases, this is accomplished by using polystyrene foam sleeves. Checking with the importing market for their specific requirements is critical because in some markets, this type of foam sleeve is not recommended.

(SOP 4 for Export Mango Cold Chain Management includes the carton box design).

5.3.2. Palletizing

If wooden pallets are used, they must comply with the ISPM 15 standard and stamped accordingly. Pallet size may vary depending on the receiving country. These international pallet sizes are applicable regardless of whether the packaging company uses wooden or plastic pallets. It is also important to note the SWL specifications, which can differ between countries.

Country	Length (mm)	Width (mm)	Height (mm)	SWL (kg)	Entry
Europe	1200	800	140	1200	4 way
USA	1200	1000	145	1000	4 way
Australia and Asia	1100	1100	150	1000	4 way

When using shipping containers for sea transport, pallets boards should not cover the air vents of cartons.

When stacking cartons onto pallets, be sure that the first layer of cartons is placed completely within the outside edges of the pallet. If the cartons overhang the pallet, carton failure is likely to occur. Subsequent layers must be stacked according to carton manufactures specification this will vary between carton designs.

The cartons on the pallet should be secured with 19mm straps, including plastic corner or tag boards to increase the pallet's rigidity. The pallet's height is determined by the strength of the carton or maximum height limits in the containers. Once packed, pallets should be moved to the cooling area as soon as possible.

5.3.3. Transportation

Except when sending to VHT treatment plants, mangoes shipped from the packing house to the export unit must be in the cold chain. The vehicle must be in roadworthy condition and have a good suspension systems. The driver should never switch the refrigeration system while in transit, except in emergencies.

5.3.4. Loading

Before loading into refrigerated trucks, inspect for cleanliness and record the temperature of the truck compartment. The truck should be pre cooled before loading, but the refrigeration system should not be turned on during the loading process. Ensure fruit has been pre-cooled. Load trucks as quickly as possible to minimize fruit heating, pallets should be removed from the cool room one at a time for loading. The same applies if the truck is loaded by hand. Avoid leaving the fruit in the loading bay for any period of time, unless it is temperature controlled.

Confirm the set temperature of the truck with the driver prior to dispatch.

5.4. Training

Training in correct handling and loading procedures for key personnel involved in preparation and transportation of fruit.

5.5. Documentation and Records

Documents required for tractability such as load identification, transport times, destinations temperature settings. Pallet stamps if using wooden pallets.

6. Temperature Management

6.1. From the Orchard to the Packhouse

It is important to use plastic crates that are well ventilated and not overfilled. The crates should be neatly stacked on a truck or other transportation vehicle. Preferably use a covered vehicle, if not available cover the load with tarpaulin ensuring that it will allow some ventilation but prevent direct sun contact with the top crates. Use a light-colored tarp material as it reflects heat. Transport the fruit during cool times of the day, such as late afternoon, evening, or early morning. Unload the fruit immediately upon arrival at the packing house. Store the crates in a clean, dry, well-ventilated, and shaded area. Do not store the fruit in the orchard for more than 6 hours after harvest. The fruit must be completely dry before it is moved to the packing house.

6.2. Packhouse

Mangoes should be packed within 12 hours of receipt at the packing house. Store the fruit at room temperature before packing. Cooling the fruit before packing will cause excessive sweating and potential skin damage.

If fruit has to be held for longer periods before packing then it should be not be stored below 18°C. If no cool rooms are available then fruit that has to be held for longer periods should not be used for export.

When the fruit is put into a cold chain, it must remain in the chain. Cooling and then warming the fruit will reduce the shelf life. Understanding the fruit's journey is important to determine the starting point for cooling. For example, fruit treated with VHT should not be pre-cooled before treatment, and fruit not being VHT treated needs field heat to be removed as soon as possible post packing.

The fruit should be placed in a cool room at a temperature setting of 5°C to 12°C. The cooling temperature regime must be aligned with the market to which it is being exported.

6.3. Plant Quarantine Processing

6.3.1. Vapor Heat Treatment (VHT)

Fruits are transported to the VHT facility without the need for pre-cooling. The fruits must leave the VHT facility with a core temperature equal to the established export transport temperature. The transport vehicles carrying the fruits to the export destination must be able to maintain the load temperature.

6.3.2. Irradiation

Fruits need to be pre-cooled before transport to irradiation facilities. The fruits must leave the irradiation facility with a pulp temperature equal to the established export transport temperature. The transport vehicles carrying the fruits to the export destination must be able to maintain the load temperature.

7. Exporting System

7.1. Air Transport

Often airfreight facilities have limited or dedicated cool room capacity and loads can sit at ambient temperature for hours before loading. Fruit should be cooled to 12-15°C and held as long as possible at these temperatures before loading onto the plane. It is important to understand what facilities are available at the airport and to minimize the breaks in the cool chain. Strict time management for receiving and completing customs procedures is important to minimize the heat impact on fresh produce and reduce interruptions in the cold supply chain.

The air cargo transport system commonly uses two types of cargo handling equipment: pallets (PMC) and containers (LD3/AKE). One pallet (PMC) is designed to carry cargo from 1,600 kg to 3,300 kg, and one LD3/AKE is designed to carry cargo from 600 kg to 1,200 kg. Air pallets allow better ventilation than AV's which can help prevent premature ripening. Some countries with phytosanitary restrictions may have specific requirements. Whether mangoes are transported in containers or pallets depends on the importing country's regulations.

For the US and Chilean markets, mangoes must be packed in sealed LD3/AKE containers with metal lids and sealed at the irradiation plant. The fruit can be refrigerated with CO₂ ice in the LD3/AKE container. In other markets where sealing is not mandatory, mangoes can be loaded onto pallets or containers.

Cargo holds often can be set a low temperatures 2-5°C which is not under the exporters control, for short duration flights this is not too much of a problem but for long duration flights then protective coverings over the loads is necessary.

It is important the fruit is mature, as it will be less susceptible to cool temperature fluctuations that can occur in the cargo holds.

7.2. Sea Transport

The transportation by sea uses 20 or 40-foot refrigerated containers which can be standard, controlled atmosphere, or modified atmosphere containers.

With all shipping containers air flows from the floor upwards, when loading the avoid large gaps between pallets and any empty floor space should be covered, this will force the air through the pallets of fruit.

Temperature settings will vary depending on the fruit variety, maturity, and distance to its destination. Export containers should be set between 8 and 12°C, with 8°C not suitable for many varieties and could cause damage. The humidity *level in the container needs to be maintained at 85-95% to avoid water loss.*

7.3. Sea Transport – Controlled Atmosphere Container

CA containers have the ability to be able to ship mangoes to long distance markets, whilst their current use in Vietnam is very limited, the opportunity to use this technology is significant.

All current containers are 40 feet and capable of adjusting CO₂, O₂ to control standard temperature and relative humidity. Setting for CA containers:

- O₂: 1.5 - 2.5% (O₂ must be maintained above 1%)
- CO₂: 5%
- Temperature: 10.5°C - 11.8°C

Note: This temperature is only used for long-distance CA container transport.

New generation CA containers cannot set O₂ below 3%. While ideal parameters will vary between varieties, these differences are not significant and in commercial containers settings will fluctuate either side of the parameters.

CA containers need to go through a climatization process post arrival where the fruit is reintroduced to ambient atmospheric conditions. It must also be conditioned by warming to 18-22°C.

7.4. Land Transport

Fruit must be precooled before loading as truck refrigeration systems do not have load cooling capacity, fruit needs to be cooled down so that the core pulp temperature is at the set transportation temperature before loading. Pre-cool the truck to the set temperature before loading. Refrigeration systems should not be switched off during the transportation from packhouse to destination. Depending on the destination and variety loads will need to be set between 12 to 15°C.

Loads need to be ventilated to avoid excessive build-up of CO₂ and maintain the humidity around 85 to 90%.

7.5. Post Arrival Management

Mangoes should be unloaded directly from the container or trailer onto a refrigerated receiving dock at the importer or DC in order to maintain the integrity of the cold chain. Holding time on the receiving dock if it is not temperature controlled should be limited to that required for identifying and recording the load and retrieving temperature recorders.

Marine container and truck trailer reefer units should be turned off while they are being unloaded. Running reefer units while unloading the cargo can cause the transfer of unwanted hot or cold ambient air and exhaust fumes into the cargo space.

Post management temperatures will need to reflect the maturity state of the fruit, and the receiver's requirements.

- Fruit ripening maintain 18 to 22°C
- Holding 12 to 15°C

- Distribution Transportation at 12 to 15°C

7.6. Cargo Monitoring

Monitoring mangoes during transportation will provide valuable information on load performance, which can support exporters in improving their systems. Shipping containers will often have inbuilt monitoring systems but access to the data needs to be negotiated with the shipping company. Alternatively small data loggers can be used in loads these can be retrieved by the importer.

7.6.1. Sensor Placement in the Container

These sensors must be connected to the data logger in the container. Throughout the journey, the temperature data will be recorded every hour and stored. At the destination this memory will be read and analysed without having to opening the container. The container of fruit must be opened and the sensors must be properly installed into the fruit. The sensor head should not pierce through the fruit. The first sensor should be placed on the second row of the pallet under the container door. This sensor should be located in the middle of the pallet (at least in one container, counting from both sides of the container) in the middle position between the cartons. The second and third sensors should be placed diagonally between the two rows of pallets about halfway back from the container (10 feet for a 20-foot container and 20 feet for a 40-foot container). These sensors should be placed between the pallets (at least in one container, from both sides of the container) in the middle position between the containers.

7.6.2. Data Logger

The temperature data loggers are important in all export operations, both for sea and air transportation. When placing data loggers in a container, it is important to clearly identify which cartons have data loggers to facilitate retrieval. Spread the loggers out through the container from front to back and top to bottom. Don't place all the loggers in the top boxes.

7.7. Training Requirements

Transporters, packers, supervisors, exporters, and quality control personnel need to be trained on the temperature management system and procedures, including carton design, loading configuration, cooling regimes, calibration, and monitoring.

7.8. Records and Documents

Documentation includes certificates of calibration, temperature logs, cool room settings and transportation configurations.

Temperature measurements taken including internal pulp temperature. Verification of cool chain system can be undertaken, if necessary, with the inclusion of transit loggers in the load.

8. Compliance and Record Keeping

8.1. Mandatory Legal Requirements

8.1.1. Registration

Export licenses/ permits, phytosanitary treatments and inspections records, pallet stamps and carton labelling

Carton labelling is a legal requirement in most countries. Each box or crate must display the following information on the outside:

- Product name
- Country of origin
- Address of exporter
- Weight
- Packing date
- Traceability to the farm or block

8.1.2. Documentation

It is critical to have the correct documentation organized prior to loading the shipment. Missing or incorrect documentation can result in significant delays and even consignment rejection. The requirements will vary from country to country. It

is therefore essential that this information is organized well in advance of exporting.

The information needed to complete the documentation includes:

- Details of the number of trays or boxes contained in the container
- Total weight of the shipment including the weight of the container
- Container number
- Seal number(s) used to seal the container
- Name of the vessel
- Voyage number
- Date of departure
- Value in local currency (as an invoice)

The exact number of packages must be included in many of the documents, as well as the number of the container, its tare weight and net weight of fruit. Seal numbers are also required.

- Phytosanitary or Plant Health Certificate - provided by quarantine inspector
- Export Certificate - The number on this form is on the lower left and is necessary for the setting of the Bill of Lading
- Bill of Lading. This is essential at port of unloading
- Invoice - An invoice is required for release of the goods on arrival

8.2. Customer Requirements

It is important to communicate with importers to understand their specific requirements. These will certainly vary between different markets. (Refer to export market requirements for more information - SOP7)

8.3. Health and Safety

Vehicle drivers must have a valid driver's license appropriate to the type of vehicle in accordance with Vietnamese road traffic regulations (motorbike: A1, three-wheeled vehicle: A3, small truck: B2, large truck FC).

- All participants in the transportation chain must be trained in occupational health and safety principles and risk analysis.
- Equipment and facilities of the packhouse must be regularly maintained and inspected to ensure the safety of workers.
- Smoking or open fire is not allowed anywhere around fruit that is handled.

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10. Appendix

Appendix 1: List of technical specifications in the packaging process for mangoes

List of Technical Specifications in The Packaging Process for Mangoes

Entrance to the packaging line: Dryness: _____ Manual: _____ Automatic: _____

Moisture: _____ Manual: _____ Automatic: _____

Coating: Yes/No Type of coating wax: _____

Temperature for drying: _____ °C Fan blowing: Yes/No Air

Fruit sorting at the packing table: Yes/No

Foam packaging at the packing table: Yes/No

Adequate lighting at the packing area: Yes/No

Stacking cartons: Manual/Machine

Carton boxes with adequate ventilation: Yes/No

Load-bearing capacity of the carton box (psi): _____

Adjusting air vents in the pallet: Yes/No Stacking on pallets: Yes/No

Number of boxes/pallets: _____ Number of straps: _____

Pallet size (floor size): x cm Material: Carton/Plastic

Comments:



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