UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

GLOBAL QUALITY AND STANDARDS PROGRAMME

SIAEP

STANDARD OPERATING PROCEDURES

Manuals

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Disclaimer

Contents

SOP 1: Exported Mangoes Field Practices

1. Introduction

The scope of this document is to provide the standard operating procedures of field practices required for the export of fresh mangoes so they have to meet the requirements of a modern retail system.

The document applies to mango business and personnel involved in the export management chain such as producers, farm managers, extension officers, collectors, packhouses, service providers and exporters.

2. Principles of Quality Management

Tree Management

It relates to varietal specifications and conformity, and impacts on tree health, disease development, fruit quality and production timing.

Nutritional Management

Nutrition impacts on internal pulp quality, including brix, physiological disorders and premature internal ripeness. Externally, it can influence fruit size, shape, peel color and the fruit's predisposition to disease and storage life.

Pest and Disease Management

Pests have significant influence on tree yield, fruit external peel quality and internal pulp quality. Pests may also impact on quarantine regulations towards importing countries and the requirements for phytosanitary disinfestation.

Disease is the most significant influence on fruit's postharvest shelf-life and its ability to be exported. Peel discolorations and markings can also be associated with some forms of disease. Some will also have quarantine implications.

Chemical Management

Managing chemicals correctly is a critical component to meet regulatory compliance requirements and residue levels. It significantly impacts the effective control of pests and diseases.

Regulation, environment, health and safety issues also are applicable.

Harvest Procedures And Practices

Many factors involved in this procedure may impact on fruit quality, fruit maturity will affect the eating quality, external appearance and susceptibility to peel damage. Harvest and transportation practices greatly influence the levels of sap burn, abrasion and bruise of the fruit.

Compliance And Record Keeping

Compliance and record keeping helps verification of management practices and meet standards, regulations, quality, environment, traceability, health and safety of workers.

3. Tree Management

Planting Stock: Plant varieties are cloned and use rootstocks that are identical in variety and age of the rootstock and are supplied/purchased from nurseries licensed by the state management agency.

Cultivation Varieties: Some popular varieties of mango are grown with good quality and exportability such as: Cat Chu, Cat Hoa Loc, Keo, and Tuong Da Xanh variety.

Propagation Materials: Grafts and grafts used for propagation must be collected from top-line plants or top-variety orchards that have been certified by competent authorities.

Planting Method

In lowland area: Planted in beds, covered in a circle, 0.5 - 0.7 m high above the water surface in the garden, then gradually accreted and lined up. Planting on either single or double raised beds.

In highland and mountainous areas: planting holes, length x width x depth 0.8 m x 0.8 m x 0.6 m. Under poor soil conditions larger holes may be required such as 1 m x 1 m x 0.8 m. The planting hole should be pre-prepared 2 - 4 weeks before planting. Apply basal fertilizer 10-20 kg of organic fertilizer and 0.2 kg of NPK or 0.5 kg of superphosphate fertilizer (if the soil is acidic, use fused phosphate) to the hole backfill with 2-3 cm of soil to ensure the tree does not sit on top of the fertilizer.

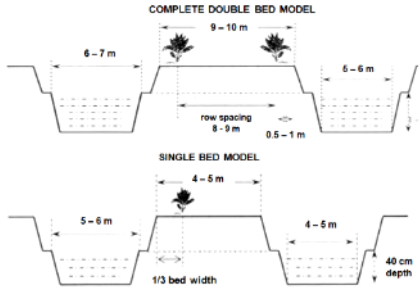


Figure 1. Modeling of types of beds

Pruning

Mango flowers from terminal shoots and therefore require high light interception for maximizing flowering potential. If trees are too densely planted they will shade each other leading to lower yields, vice versa low-density planting will also result in lower yields.

Pruning is conducted for several reasons Structural to establish the tree architecture, maintenance pruning to maintain the canopy structure, for maximizing light, for yield and for orchard hygiene by the removal of dead and diseased pruning, and rejuvenation pruning to return older trees back to productivity.

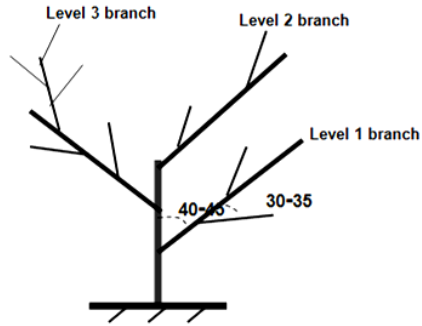


Figure 2. Creating a canopy at the basic construction stage

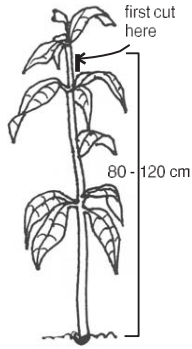


Figure 3. Cut the buds after planting

Figure 4. Choose 3 buds to make level 1 branches

When the tree is about 1m high, cut the buds, choose 3 new shoots that are evenly spaced, strong and straight growing from the main

stem, growing in 3 directions, making the first level branches the most ideal. Using a level 1 branch holder to create an angle of 35-40 degrees with the main stem, continue to do this technique for the second and third branches for a balanced tree, continue this on subsequent growth flushes, until the tree has a vase shaped frame that is capable of supporting the fruit load.

The pruning is done every year after harvest to stimulate the tree to produce new buds early and simultaneously the first time is after harvesting. Maintenance pruning also is required to improve light penetration in the canopy, maintain canopy size, synchronizes growth flush, removal of dead and diseased wood.

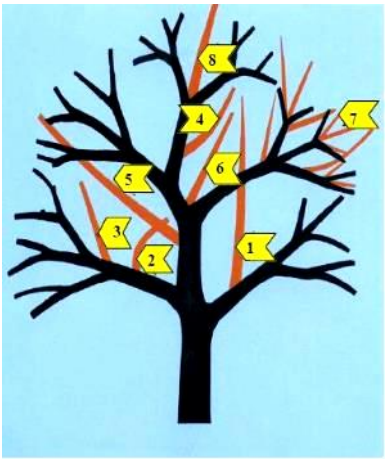


Figure 5: Maintenance pruning

Figure 6. Creating a low tree height

Figure 7. Creating a canopy inside and at the top

Irrigation

Mango requires adequate water at each growth stage with the most critical period for watering is from floral bud break to just before harvest a good water supply is also important for the postharvest flush followed by a reduction of water leading to the floral initiation to promote uniform flowering. The dike system which creates a basin around the base of the tree to manage water in the mango orchard is important to manage water runoff.

In areas prone to salinization in the dry season, it is necessary to build dikes to prevent salinity, wide canals and ditches to store fresh water for irrigation.

Use water saving irrigation techniques.

Figure 8:Irrigation method

Tree Ages		Water Demand (Liters/Week)
Years	Rainy Season	Dry Season
1	20	50
2	100	250
3	200	350

Table 1: Water demand of tree at each time point

Floral induction

Stimulating flowering is an important management measure that enables production to match market opportunities. Several practices can be taken to stimulate and promote flowering, including smoking (Smudging), chemical treatment such as Ethephon, potassium nitrate or Paclobutrazol (PBZ), Uniconazole (UCZ) as the active stimulant prefer flowering mango can replace PBZ in the future. Using PBZ to stimulate flowering of mangoes is widely applied in current mass production, use label rates when applying.

After PBZ treatment, it is necessary to keep moisture for 10-15 days for the plants to be able to absorb the product.

Treat with PBZ at label rates when young leaves are fully expanded but still at copper-red and 10-15 days old. At 25-30 days after PBZ treatment, apply DAP + KCl with the ratio 1:1 and spray MKP 0-52-34 with the recommended dosage, once every 10 days, spray 2-3 times/season. 45-60 days after PBZ treatment, spray KNO3 to stimulate flowering. Spray during dry weather when shoots have matured and leaf veins are protruding or curled; 5-7 days after spraying a second time with a reduced dose of 50%. The treatment will vary between Cat Chu,Cat Hoa Loc and Green Skin varieties. Try to avoid inducing a flowering in a period where heavy rain is likely to occur.

Figure 9. Time of treatment with PBZ

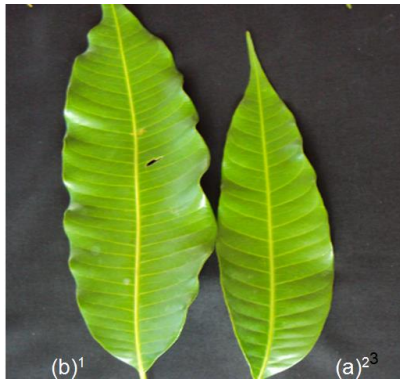


Figure 10. Leaves 1 month after PBZ treatment

Flowering

Gibberellic acid (GA3) can be sprayed before flower buds differentiation to inhibit flower sprout formation with a dosage of 1g GA3/200 liters of water, which has the effect of delaying flowering, and will reduce the percentage of damaged shoots, which create favorable conditions for good flowering plant.

Observing flowers for pest and diseases occurrence when raining is likely at flowering, then there will be a need to protect the flowers with fungicidal applications.

It is necessary to minimize any spraying at flowering time to avoid impact on pollinating insects and not use any synthetic pyrethroid insecticides at this stage.

4. Nutritional Management

Nutritional management is critical for both productivity and fruit quality. It is important to understand the tree's needs at each growth phase and what the crop is removing from the soil.

A good nutritional program will be based on soil type, crop removal, soil and leaf monitoring. There are no universal recommendations that are suitable for all orchards.

Soil Analysis

Soil analysis is a useful tool for determining background levels of nutrients, it also provides a more accurate assessment of Calcium levels than what can be obtained for by other methods. To sample, take soil from the 0 to 15 cm zone. An additional deeper sample will also give a better picture of the nutrients available as some nutrients can accumulate at lower depths in the profile. This will require a 30 and 50 cm sample. Sample about 5-10 sites in each block, using a soil

auger or spade. Mix the samples in a clean bucket and take a subsample to send to the laboratory. If fertilisers have been applied recently, scrape the top soil away to avoid sample contamination.

Leaf Analysis

The best time to take a leaf sample is a month prior to flowering. Take leaves from the most recently matured shoots. It is best to take the third or fourth leaf down from the tip of the shoot. Avoid terminals that have not flushed with the rest of the tree. Take leaves that are healthy and disease-free. You will need between forty and fifty leaves. Take leaves from all four sides of about 15 trees spaced throughout the block. Do not sample leaves that have been sprayed with foliar nutrients as the result will be contaminated with the residue.

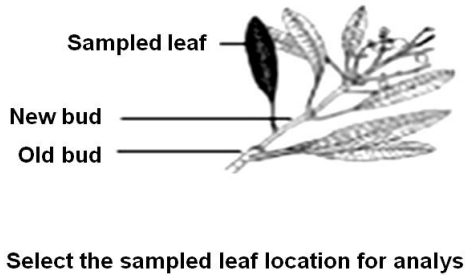


Figure 11: Leaf sampling location

Leaf analysis (Quaggio[a] and MIK[b])				
	Lack	**Excess**	**Sufficient**	**Optimal**
N (%)	< 0.8	> 1.6	1.2 - 1.4	1.0 – 1.5
P (%)	< 0.05	> 0.25	0.08 – 0.16	0.08 – 0.18
K (%)	< 0.25	> 1.2	0.5 – 1.0	0.3 – 1.2
Ca (%)	< 1.5	> 5.0	2.0 – 3.5	2.0 – 3.5
Mg (%)	< 0.1	> 0.8	0.25 – 0.5	0.15 – 0.4
S (%)	< 0.05	> 0.25	0.08 – 0.18	0.2 – 0.6
B (ppm)	< 10	> 150	50 – 100	50 – 80
Cu (ppm)	< 5	-	10 – 50	10 – 20
Fe (ppm)	< 15	-	50 – 200	70 – 200
Mn (ppm)	< 10	-	50 – 100	60 – 500
Zn (ppm)	< 10	> 100	20 - 40	20 - 150

Table 2: Analysis results of leaf samples

Application

Young trees

Fertilizer application is done only when the trees have shown signs of growth and first flush is hardening. Apply small but regular quantities every 6 – 8 weeks. Do not apply excessive quantities as this will lead to over vigorous shoots that can break, as well as lead to root and leaf burn. Every year, it is necessary to add organic and bio-organic fertilizers for plants

Bearing Trees

Fertilizer requirements will vary according to each soil type. There is no single fertilizer formula suitable for all mango trees in the same region,however, as a general guide, the following program is a starting point and can be refined with the use of leaf and soil analysis and orchard cropping history.

Fertilizer dosage reference (grams of fertilizer/tree/year)			
Tree age (year)	**Nitrogen (N)**	**Phosphorus (P)**	**Potassium (K)**
1	70	25	200
2-3	140	50	200
4-6	210	75	250
6-7	280	100	375
8-9	350	125	500
>10	420	150	650

Table 3: Recommended dosage of fertilizer

Trees will require nutritional at critical points in the phenological cycle. Application timings need to be based on the phenological cycle post-harvest, leaf flush, pre-flowering and floral and fruit development.

Every year, it is necessary to add organic and bio-organic fertilizers for plants once calculated the total quantities of nutrition the ratios of application for major nutrients should follow:

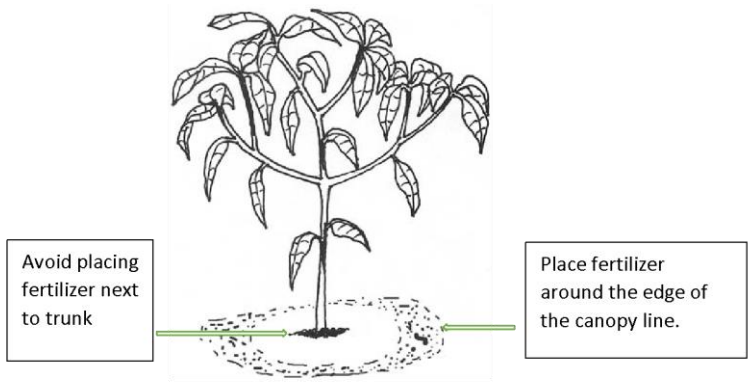
Leaf flush N 60-70%, P – 100%, K – 20%, Ca - 40-60%
Pre-flowering N - 30-40%, K – 20%, Ca - 40-60%
Flowering K 40%
Fruit development K 20% or refer to [4].

Implement balanced fertilizer application to improve product quality and value and prolong storage time.

Application Methods

There are three main ways of applying fertilizer:

1. Broadcast, either by hand or mechanical spreader Traditional practice in Vietnam is to dig a basin around the tree canopy, mix the fertilizer evenly into the soil. This will assist in the reduction of nutrient loss due to runoff.
2. Fertigation, dissolved nutrients applied through irrigation
3. Foliar application, sprayed onto the leaves of the tree, this is more effective on young growth flush, do not exceed 1% concentration to minimise the risk of damage.



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5. Pest and Disease Management

Insect pest management

Farms should work towards an integrated pest management (IPM) and integrated crop management (ICM).

These are pests that importing countries may have specific restrictions on farms.

The following are quarantine pests:

- Fruit fly (*Bactrocera dorsalis, Bactrocera corecta*)
- Mealybugs (*Pseudococcus sp., Rastrococcus spinosus*)
- Fruit borer (*Noorda albizonalis*)
- Scale insects
- Seed weevil

However, depending on the importing country, there will be specific objects.

The following pests are less likely to be present on export fruit but would still be prohibited requirements under most importing countries:

- Mango leafhopper (*Idioscopus spp*.)
- Leaf cutter beetle (*Deporaus marginatus*)
- Young branch borer (*Alcicodes sp*.)

- Stem borer (*Plocaderus ruficornis*)
- Red mite (*Oligonchus sp*.)
- Thrips (*Scirtothrips dorsalisHood*)

Monitoring is to identify accurately pests and beneficials.The owner of farms need to monitor changes in pest levels, build up a history of information to identify patterns, identify problem areas of “hot spots” “in the orchard. This enables us to control methods in the right places, time and for the right reason.

Threshold is the level at which a pest begins to compromise plant growth, development, and yield. The economic threshold is the level of pest at which the cost of control measures is less than or equal to the value of the product obtained as a result of control.

Disease Management

Refer to **SOP 3: Standard Operating Procedures for disease management of exported mangoes**.

Fruit bagging

This will improve the quality of the skin by preventing rubbing from damaging the fruit, creating a physical barrier that protects the fruit from insect damage. The packaging of fruit can help reduce some diseases and fruit cracking, reduce the number of spraying times, reduce environmental pollution, and prevent pesticide residues on fruit.

Bagging process should apply at 30-45 days after fruit set, spray with fungicide prior to commencement of bagging.

Figure 12: Types of fruit bags and fruit packaging techniques

Figure 13. Specialized chair for fruit packing

Figure 14. Ladders used for packing fruit

6. Harvest procedures and practices

Fruit Maturity

Fruit maturity can be determined by several factors. Currently maturity is determined by the calendar method e.g. days after bagging, whilst useful this method is not all that accurate as it does not take into account climatic conditions during fruit development. Export markets are very particular in regards to maturity as it will affect its transportation and sale potential. It is therefore very important to harvest fruit at the right maturation stage.

Heat Units

This method is currently not used in Vietnam but has proven to be highly accurate as it measures the accumulation of heat from the time of fruit set till maturity, the figure is generally between 1500 to 1600 heat units this will vary between varieties. This system, once calibrated, is quite accurate and non-destructive. It is also very good for predicting maturity based on historical weather data and flowering dates.

The method for demining this is (Max day temp + Min day temp)/2 = daily heat unit. To measure this it requires a Maximum/Minimum thermometer.

External Attributes

Some varieties will exhibit external characteristics such as smoothing of the skin, rounding out of the cheeks and/or sinking around the peduncle at the top of the fruit. Many export markets will

evaluate fruit by external attributes on receival so it is important that the descriptions are done for each export variety.

Internal Attributes

Once mature the internal flesh color of the fruit will turn a light butter color (depending on the requirements of the importing country) this method is used extensively by other export countries. This is a quantifiable but destructive sampling method so only choose representative fruit. Standards need to be set for Vietnamese varieties.

Dry Matter

This is a fairly accurate method for determining ripening time. Standards should be established for each category.

The dry matter content of the fruit pulp was determined by the drying method. The method was carried out as follows: the petri dish was washed, dried and weighed (W0). Then, put the sample on a plate and cut into small, thin pieces, and weigh the fresh weight (W1). Samples were dried at 60°C for 1 week and cooled in a desiccator for 25 to 30 minutes and weighed (W2). Continue to put in the oven for 30 minutes, remove to cool in a desiccator and weigh again as above until the amount of substance remains constant.

Weight of dry matter (%) = [(W2 – W0) x 100]/(W1 – W0)

Where: W0 = petri dish weight (g), W1 = fresh weight of the sample (g),

W2 = in the dry matter of the sample (g).

Specific Density

This is correlated with dry matter and can be determined by placing the fruit in a water solution density 1.0 whereby the mature fruit will tend to sink. Results from this system can be variable and it may not be suitable for some types of export systems.

Traceability

A Production Unit Code (PUC) needs to be allocated to the exporting farm.

Labelling of boxes, cartons or containers of consigned products from the farm is to identify the origin and batch of the products consigned in accordance with theNational Standard: TCVN 12827:2019 Traceability - Requirements for fresh fruit and vegetable supply chain.

Records of each consignment of consigned products indicate identification of orchard, location, production unit code number, product and variety, date of harvesting and to whom transferred.

Products must be supplied only to operators (producers or intermediate suppliers) which apply traceability systems as defined in

TCVN 12827:2019 Traceability - Requirements for fresh fruit and vegetable supply chain.

Each consignment should be accompanied by a declaration of agro-chemical treatments applied (product applied and date, or non-treatment if that is the case).

(Refer to **SOP 6 Standard Operating Procedures for traceability of exported mangoes**)

Harvesting

Determine maturity according to market requirements traditionally Cat Hoa Loc is harvested 85-90 days after flowering and off-season at 80-85 days after fruiting. Cat Chu at 80-85 days after flowering. However this times will vary as some markets will require more advanced maturity

Picking the Fruit

Fruit picked with poles need assuring that the stems of the fruit are not broken, stalks should be a minimum of 5- 10 cm long. Harvested fruit is carefully placed into a crate or onto a tarpaulin with stems intact, any fruit where the stems are broken needs to be isolated and placed in a separate group. Fruit should never be placed directly on the ground or allowed to come into contact with soil.

Sap Management

Mango sap is highly acidic when it comes into contact with the peel. It will cause damage from severe burning to skin browning, harvest procedures must minimize the potential for the peel to come into contact with the sap.

Preferably the destemming process should be carried out in the field.This can be done by breaking the stems with the fruit upside down so the spurt sap flows away from the fruit, the fruit is then placed into a lime wash solution to neutralize the pH for 2 minutes before being placed in open crates to dry. Alternatively, the fruit can be placed stem end down on racks so the sap will flow away from the fruit. It will need to be on the racks for 20 minutes.

If the destemming process takes place in the packhouse, fruit with stem must be carefully placed into crate assuring that the stem is in a position where they will not break. Fruit contaminated with sap and with a broken stem needs to be kept separate to avoid cross contamination.

Field Handling

Any pre-sorting that occurs needs to follow specifications established by packhouses. Plastic crates should be used to transport fruit to packhouses, do not overfill crates with fruit. Fruit needs to be

kept in the shade until transported to the packhouse, fruit should not remain in the field longer than 6 hours after harvesting.

Equipment Requirement

Required facilities are secateurs, knife, picking poles, plastic crates, water containers, water, chlorine (if water used is potently contaminated), lime (food grade) or desapping powder and drying racks.

Equipment Maintenance and Cleaning

Picking poles must be cleaned with lime wash solution if they are contaminated with sap from broken stems. Plastic crates need to be washed every time after single use to avoid cross contamination from sap. All other equipment needs to be cleaned every day or sooner if it is contaminated with sap.

Transport

Means of transport must be regularly cleaned and maintained to minimize contamination of fresh fruit. Transport vehicles must be inspected for cleanliness, chemical leakage and pests prior to use. Vehicles must have good suspension.

Carefully stack crates making sure that they are not overfilled.

Check the bottom of the container when stacking fruit containers on top of each other to avoid soil or dirt on the produce. If necessary, clean the bottom of the container or do not stack the containers on top of each other.

To avoid biological, chemical or physical contamination during transportation of products, they must be covered with protective materials.

Transport fruit during the cool time of the day - early morning or late afternoon.

SOP 2: Export Mangoes PackHouse

1. Introduction

The packhouse is a critical component for the export chain where product can be received, sorted, and graded to specification, post-harvest treated for disease, packaged, and cooled to the requirements of the export market.

2. Principle implementation of SOP

Principle 1: Packing house infrastructure.

The packing house for export products meeting the modern retail system requires infrastructure needed for operational procedure appropriate to that system. Packing houses must also meet the conditions for a packing house code.

Principle 2. Processes

The activities within a packing house that enable the operation to process products to be able to meet specifications and market requirements. Each activity can have an impact on quality and potentially shelf-life of the fruit.

Principle 3. Product flow

Understanding the movement of product through the packhouse requires capabilities of the identification of critical control points influencing the quality of storage products.

Principle 4. Quality Assurance

To maintain constancy in product output that will meet market requirements a program of systematic checks and verifications will ensure the product consistently meets specifications.

Principle 5 Compliance

Verification of management practices needs meeting requirements of standards, regulation, quality, environment, health and safety.

3. Content of implementation

3.1. Packhouse infrastructure

The location of the packing house must have good access to transportation infrastructure, power supply, clean water source, reliable communication, and fire protection system. The facility must also have a solid structure, enough protection from the sun and rain, good ventilation, and suitable hygiene. The layout of the packing house must allow for unidirectional flow of product, practicality in maintaining a clean environment, and exclusion of vermin.

3.2. Processes

Packhouse process is the specific steps for handled mangoes for the target markets. The process includes a few steps, including

receivals, de-sapping, cleaning, diseases treatment, sorting and grading, ripening (if necessary), packaging, pre-cooling, and cold storage. If excess fruit cannot be treated and packaged immediately or transport is delayed, holding capacity in the packinghouse is necessary.

3.2.1. Receivals inspection

On receiving product into the packhouse, it is the responsibility of the appointed quality supervisor to collect, assess and record samples, verify documentation and report to the packhouse manager when necessary.

Traceability and compliance

Verify consignment either directly from programmed orchard with an allocated producer unit code and registration of packing house facility or indirectly from an intermediary supplier with registration of packing house or from an orchard certified GlobalGAP, organic (if any).

Quality inspection

A random sample of each consignment is assessed with a representative of 2% of the fruit.

Each fruit is inspected for maturity, softness, external appearance, contamination and the presence of pests and disease. A cut test is recommended for fruit that is suspected immature, the internal colour of the fruit can be matched against maturity standards.

3.2.2. Desapping

The preferred method is that the desapping process happens in the field at harvest as this will give the best quality results.

Method 1: Desapping onto racks

Hold the fruit upside down while cutting the stalk of fruit at the first knuckle 0.5 to 1.0 cm with a pair of clean sharp secateurs allowing the spurt sap to come out without touching the skin of the fruit.

Inverting freshly de-stemmed fruit on plastic or steel mesh racks, allowing the latex to drip out for about 30 minutes.

Method 2: Lime desapping

A stainless-steel water holding tank is preferable. The water in the tank is added with food grade lime to make 0.5% solution. This solution will neutralize the acid in the sap.

The stem is then either broken by holding the mango upside down pulling the stem towards the body while moving the mango away from the body. After the initial spurt sap the fruit is placed in the solution plastic crates can be used to hold the fruits during dipping. Fruit should only be held in the solution for a minimum of 90 seconds and a maximum of 120 seconds before removing. The solution in the tank

needs to be replaced when a noticeable oil layer builds up on the surface.

3.2.3. Washing

Figure 27: Mangoes washing system

Mangoes often come into the packhouse covered in residue or sap and require a level of cleaning, in modern packing lines this is conducted over mechanized smooth rotating brush units while subjected to overhead water sprays. If such equipment is not available it is recommended only to manually wash the fruit if it has visible residue on the skin that needs removing, this can be done with clean damp soft cloths.

3.2.4. Grading and Sizing

Correct sizing is important as this will facilitate ease of packing and assure carton weights are within specification and the final pack is uniform. Sizing can be done either mechanically or manually and is generally based on weights and related to the counts in the cartons. The tolerance levels between the weights will vary.

Grading is measured by national standard or by a customer specific standard. Around the world, many mango classification standards are based on the Mango Codex Standard 184-1993.

To follow specific standards graders need to be trained. Mangoes are graded into 3 classes, including extra class, class 1, class 2.

Fruit that is graded out of specifications is segregated into plastic crates are removed at the end each working shift from the packing area and are distinctly labeled for disposal.

3.2.5. Postharvest disease treatments

Intervention with a post-harvest treatment for disease is a critical component for successful exporting of mangoes. Treatments will suppress the development of diseases and the level of suppression will depend on several factors such as the level of inoculum, disease profile, temperature of the water and duration of treatment.

Hot water treatment (HWT): HWT is to control for post-harvest diseases. There are two distinct systems for applying HWT in a packing house.

Figure 28: HWT treatment system

Batch system: The fruit is immersed in a hot water bath at 520C for 5 minutes. Ensure that the water is circulating with a pump so that there is an even water temperature, monitor the water temperature, make sure the fruit is fully submerged for the duration of the treatment.

Flow thru systems: The fruit is exposed to a continuous hot water spray at 52^{o}C for 5 minutes. Monitor the water temperature constantly to ensure a spray that the fruit is rotating and a dip that it is forced under the water for the duration of the treatment.

Efficacy can be greatly enhanced by the addition of postharvest fungicides. Check products permitted status in Vietnam before using. Ensure the chemical is permitted by the importing country. Follow manufacturer's label for dosage, top up requirements, mixing and safety procedures.

3.2.6 Drying

After the hot water treatment, the fruit should be cooled down and drained before packing by placing it in a plastic container in a cold room for a few minutes. This process can be enhanced by using fans to move air across the surface of the fruit.

3.2.7 Packing

Mangoes are manually packaged in carton boxes. As required by some markets, each mango can be wrapped in a foam net before being packed into cartons.

The packed carton must meet the specified minimum weight, allowances need to be made for weight loss so packs should add an average of 5%.

Refer to **SOP 4 Cool chain management for export** and SOP 5 **Transportation for export mangoes** for information on carton designs.

Figure 29: Example carton boxes

Figure 30: Packaging Process

Fruit placement

Fruit must be of uniform size, packed in the same direction and position, preferably stem end facing downwards. The use of white expandable polystyrene, netted sleeves is common in some export packing houses. They will often make uniform packing and meeting the minimum carton weight more difficult, it is important to check with the importing country before using these sleeves.

Figure 31: Standard Fruit placement

Labeling

Carton labelling in most countries is a legal requirement. Labeling needs to comply with Decree No. 111/2021/ND-CP on goods labels or labeling according to the regulations of the importing country.

Each product carton or tray must have the following information visible externally:

- Product
- Country of origin
- Exporter's address
- Weight
- Date packed
- Traceability to Orchard or block (Production Unit Code Number, Packhouse Code and Lot Number)
- Treatment Facility Code (TFC): for irradiated or heat treated (VHT) products (if applicable)

Traceability data should be recorded and labels applied using the GS1 International Traceability Standard, as set out in TCVN 12827:2019

(Refer to **SOP 6 - Standard Operating Procedures for traceability of exported mangoes**)

3.2.8. Ripening

Some markets, particularly those where airfreight is being used, may require the packing house to partially start the ripening process.

This is conducted in a suitable temperature-controlled room where ethylene is introduced either via gas injections or catalytic ethylene generator. Ripening room temperature needs maintaining between 18 to 22°C. Treat with an ethylene concentration at 100 ppm for 24 hours to activate the ripening process, CO_2 needs to be maintained below 1% this can be achieved by venting the rooms 10 to 15 minutes every 6-8 hours.

It is necessary to locate ripening rooms away from storage areas containing produce that could be damaged by exposure to ethylene.

3.2.9. Quality monitoring

The purpose of quality monitoring is to ensure that product marketed under packing house brands meets the quality and packing standards defined in the product specifications. Monitoring staff check packed products to ensure that it meets the quality and packing standards.

3.2.10. Palletizing

Most modern markets will require the cartons to be palletized for ease of movement.

Refer to **SOP 5 Transportation for export mangoes**.

Completed pallets should be transferred to a refrigerated area as soon as possible.

3.2.11. Pre-cooling and cold storage

After packing the fruit requires cooling unless it is to be sent for VHT treatment. For pre-cooling operations and cool chain management

Refer to **SOP 4 Standard Operating Procedures for cool chain management of exported mangoes.**

3.2.12. Loading

Before loading into refrigerated trucks, inspect the trucks for cleanliness and record the air temperature. Trucks must be cooled to cold storage temperature before loading. Ensure the fruit has been precooled. Loading cooled products on trucks as quickly as possible

to minimize fruit heating, pallets should be removed from the cool room at once at loading time.

Ensure that the proper temperatures are maintained throughout the trip, pre-cool the produce and the truck before loading.

3.3. Product flow and general procedure

3.3.1. Product flow diagram

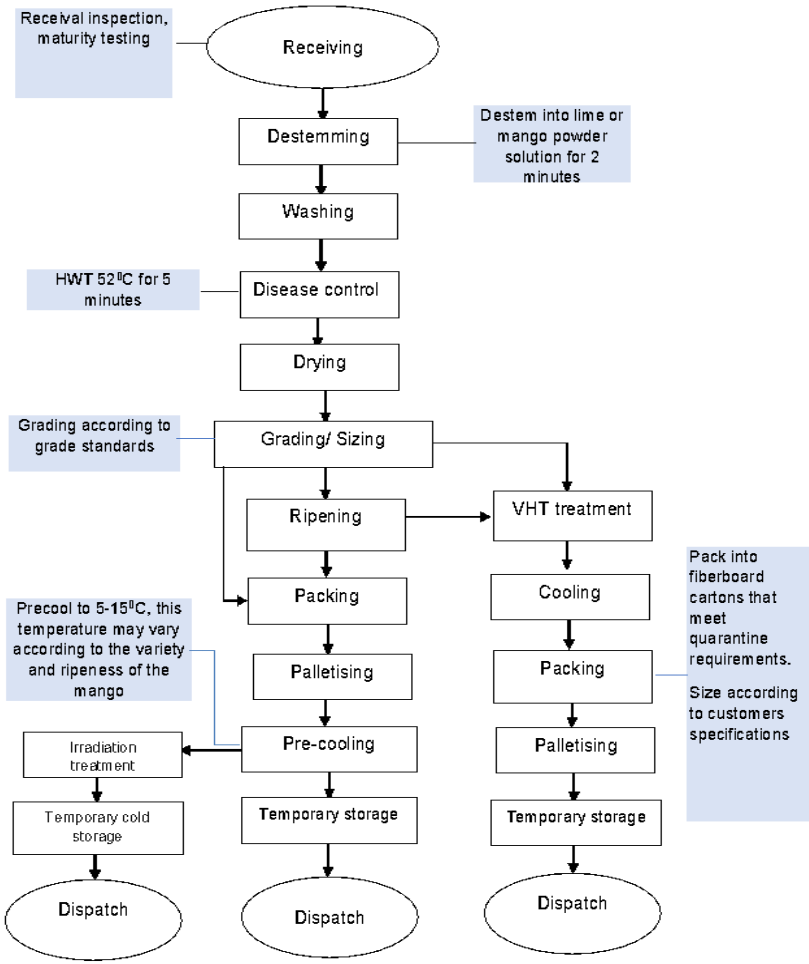


Figure 32: Process flow for mangoes destined for export markets.

3.3.2. Isolation pathways

To ensure the integrity of goods being prepared at the packing house:

- measures in place to minimise the risk of infestation or contamination.
- measures to keep export goods which have acquired a phytosanitary status separate from goods which haven't.
- measures in place to minimise the risk of substitution (switching of goods)
- for goods which have reached a phytosanitary status they must meet the phytosanitary security requirements.

3.3.3. Implementation of hazard based internal control system

An exporting packhouse for supplying the modern retail market needs to operate under "Hazard Analysis Critical Control Point (HACCP)" principles. This enables hazards to be identified and controlled before they threaten the safety of food and consumers.

3.3.4. Cleaning schedules

Facility cleaning & Sanitation

Packhouse sanitation needs to cover the interior and exterior of the facility, and equipment installed. A staff member should be assigned to managing the packing house sanitation.

Personal Hygiene

Every person working at the pack house facility has to maintain a high degree of personal cleanliness. Staffs are potentially the greatest source of contamination as they are in physical contact with the fruit. All staffs working in the packing area must undergo periodic health checks at least once a year, and must ensure that they do not contract infectious diseases when participating in production.

3.3.5. Pest control procedure

Pests commonly found in a packing facility include insects, rodents, reptiles and birds. Pets such as cats and dogs, while not normally considered pest can be a significant source of contamination and must be excluded from the packing house. Maintaining effective control of pests is necessary to prevent disease and contamination.

3.3.6. Waste management procedure

Developing a waste removal schedule includes:

- Keeping frequency and methods of waste removal.
- Keeping waste storage areas clean and far away from the processing area.
- Cleaning waste receptacles.

3.4. Internal audit

An internal audit is a more formal verification process to ensure a packed product meets product specifications. A designated quality control personnel should be assigned to the task.

SOP 3: Diseases management for export quality

1. Introduction

Disease management is the single biggest limitation for export development of mango. An integrated pre- and post-harvest disease management protocol will ensure adequate control of mango diseases in the chain.

2. Principles of Diseases Management for Export Quality

Principle 1: Inoculum Reduction

Practices are targeting to removing and/or minimizing the level of inoculum that is present within a producing orchard, and other critical points in the chain where fruit is exposed to high levels of pathogens. Reducing inoculum levels will lower the infection rates and greatly enhance other additional control methods.

Principle 2: Protecting The Host

Almost all post-harvest pathogens inoculation occurs at the preharvest level. Measures and practices to control the pathogens need starting at this stage to have an effective disease control program. An understanding of disease profiles, varietal resistance, conditions of spread and effective chemical control is necessary to implement good preharvest control practices.

Principle 3: Inhibiting Disease Development

Effective post-harvest control strategy is necessary to enhance the impact of the preharvest control programs.

Principle 4: Storage And Transportation

Disease development is greatly influenced by storage temperature, temperature fluctuations in transport and storage duration.

Principle 5: Ripening Management

Fruit ripening techniques can assist in management of disease development and help maximize the saleable life of the fruit for retailers. This essentially brings the greener fruit forward to a saleable level reducing the presale storage and natural ripening time required.

Principle 6: Compliance And Record Keeping

Compliance and record keeping helps verification of management practices and meet standards, regulations, quality, environment, health and safety.

3. Inoculum Reduction

3.1. Orchard Layout and Planting Material

Planting varieties must meet the criteria of GAP or VietGAP.

The best method to control disease is to keep the inoculum from entering the orchard in the first place.

The orchard layout and planting material for mangoes require varieties that meet GAP or VietGAP criteria.

3.2. Orchard Sanitation

Removal of diseased material by pruning, including dead or damaged leaves, twigs, branches, flower panicles and old fruit.

Clean and sterilize all pruning and other equipment used in the orchard or packing shed.

3.3. Orchard Management

Pruning: Prune trees to remove old leaves, prune to open up the canopy that will allow good airflow.

Nutrition and Disease: Do not use excessive nitrogen applications. Keep nitrogen in the range of 1.0 - 1.5 % “leave concentration”. Ensure calcium soil levels are maintained to at least 1,000 mg/kg. Maintain boron levels between 50 – 70 ppm “leave concentration”.

Harvesting: Clean and sterilize all harvesting equipment regularly. Do not place harvested fruit on the ground or allow contact with soil.

4. Protecting The Host

It is important to correctly identify the disease as the approach to managing it will vary depending on which disease is more prominent.

Some key diseases of mango in Vietnam that can affect the export of fruit. The diseases are Anthracnose, Stem end rots, *Alternaria alternata*, *Bacterial blackspot Xanthomonas campestris pv. Mangiferae*, and Transit rots. Other minor diseases may include Mango scab, Frog skin disease, Powdery mildew, Red rust, Pink mold, Leaf blight disease, Sooty mould, and Crack stem and sap flowed.

Figure 33: Stem end rots Disease

Figure 34: Anthracnose Disease

Conditions of Spread

Fungi are spread by wind and water splash, and through the movement of contaminated soil, animals, workers, machinery, tools, seedlings and other plant material. High humidity and warm temperatures will exacerbate the spread, especially when combined with high levels of inoculum.

Fungicide treatments

There are 2 types of fungicide. Protectant fungicides are sprayed as a preventative measure to stop the disease from developing on the surface of the plant, while systemic fungicides are absorbed into the plant and can be used to suppress the disease after infection.

Another method for controlling pests and diseases is by using bags to cover the fruit. This helps prevent the attack of insects and diseases such as fruit borers, fruit flies, mealybugs, anthracnose disease, frog skin spot disease, and fruit cracking disease.

5. Inhibiting Disease Development

5.1 Heat Treatment with Hot Water Immersion

Inhibiting disease development in mangoes can be achieved through heat treatment with hot water immersion or hot steam. Hot water immersion treatment at 52^{o}C for 5 minutes can be used to suppress the development of diseases such as SER, anthracnose, and Alternaria. Steam heat treatment involves heating fruit with steam-saturated air at 47°C to eliminate insect eggs and larvae.

5.2. Post-Harvest Chemical Treatment

Hot water treatment efficacy can be greatly enhanced by the addition of post-harvest fungicides.

These options are currently being trialed in Vietnam for registration purposes. Check products permitted status in Vietnam before using. Ensure the chemical is permitted by the importing country

Follow manufacture labels for dosage, top up requirements, mixing and safety procedures.

5.3. Packhouse Hygiene

Packhouse hygiene is also crucial to prevent disease spread, and a regularly scheduled cleaning and sterilization of floors, packing lines, equipment, and cool rooms is recommended, along with the removal of all old and rotted fruit.

Sterilize surfaces of tools/ equipment with alcohol at 70% or 200ppm chlorine solution.

6. Chemical Management

The use of chemicals in agriculture should be limited to permitted registered products obtained from licensed suppliers. It is important to check the list of pesticides allowed and banned for use in Vietnam. Additionally, it is essential to ensure that the chemicals used are permitted in the importing country, especially if the crops are designated for export.

6.1 Managing fungicide resistance:

Fungicides are at high risk of developing resistance, and the growers can manage it by minimizing fungicide use, reducing inoculum load in the orchard, using protective bagging, using mixtures, rotating sprays, reducing the number of spray applications, and targeting critical times when disease pressure may be high.

6.2 Managing MRL's

Carefully check the importing country's MRL, use chemicals according to the instructions on the product label, do not exceed spray applications, ensure that spray equipment is correctly calibrated,

6.3 Storage

Chemicals should be stored according to guidelines. Storage areas should be periodically checked for expired or banned chemicals, well ventilated, and have a solid sealed floor with a surrounding lip to contain spills.

6.4 Safety procedures

Personal protective equipment (PPE) that meets label and MSDS guidelines should be used. Before opening a product, the label should be read for safety and loading guidelines, and label guidelines should be followed in well-ventilated areas. ld be cleaned, and runoff should be removed.

7. Storage and Transportation

7.1. Temperature management within the chain

To prevent disease development in exported mangoes, it is important to manage the temperature during the transportation chain. Lower temperatures generally suppress disease development, while fluctuation in temperature can increase disease expression. Ensure loads of mangoes are correctly cooled by the set temperature measured the internal pulp temperature. To avoid breaks in the cool chain, pulp temperature needs to be maintained throughtout the chain.

7.2. Long term storage (Including sea freight)

Fruit with low levels of disease can be stored for up to several weeks under the right conditions.

Long term storage will only work if fruit are correctly treated for disease pre- and post-harvest, generally this will include a post-harvest fungicide treatment.

Control environment and modified atmosphere conditions will increase the storage time and suppress disease while in the containers.

After long term storage disease can develop rapidly.

8. Ripening Management

Proper ripening of fruit is important to reduce storage time necessary to bring the fruit to its display ripeness, thus giving less time for disease to develop.

8.1. Ripening systems

In order to ensure uniform ripening across a consignment of fruit and reduce storage time, fruit should be ripened in a controlled room at a temperature between 18 and 22^{o}C using Ethylene gas.

8.2. Storage of ripened fruit

After mangoes are ripened in a controlled room with ethylene, it's important to collect data and record it on a mango evaluation and ripening log. This log will help in fine-tuning the specific mango ripening protocol. Once ripened, mangoes can be stored at 12-15°C and 90-95% relative humidity for short periods.

8.3 Documentations and record keeping

On exposing fruit to ethylene, duration, process and concentrations of ethylene, temperature settings and ventilation procedures are documented and kept in records.

SOP 4: Cool Chain Management for Export Mangoes

1. Introduction

Mango belongs to the climacteric fruits category, these are fruits that they continue to ripen after harvest. During the ripening process the fruits emit ethylene along with an increased rate of respiration. This process must be managed throughout the cool chain to maximize shelf life and obtain the best quality out-turn.

Key definitions

Field heat is the difference between the temperature of the harvested crop and the optimal storage temperature of that product.

Forced air cooling is accomplished by exposing packages of produce in a cooling room to higher air pressure on one side than on the other.

2. Key Principle

Management of field heat

Quick removal of field heat and minimizing temperature fluctuations within the fruit can substantially increase the shelf life and reduce disease expression. In general, the product should be cooled down till its temperature reaches 88% of the existing difference in temperature and its optimal storage temperature.

Temperature management practice and systems

Transportation practice can greatly influence fruit pulp temperature. Airflow, packaging design, load configurations, refrigeration cooling and ambient temperature conditions all have a role in how the temperature is managed throughout the supply chain.

Physiological process

As mango is a climacteric fruit and will generate significant amounts of heat during the ripening process. Exposure to ethylene, and/ or higher temperatures can trigger the ripening process, which must be managed throughout the supply chain to maximize fruit shelf life.

Compliance and record keeping

Verification of management practices meeting standards, regulatory, quality, environmental, health, traceability, and safety requirements.

3. Management Of Field Heat

3.1 Harvesting

3.1.1 Time of harvesting

The time of day when mangoes are harvested can affect their pulp temperature, with fruits harvested during cooler times having

lower temperatures. The recommended time for harvesting mature fruits is from 9:00 in the morning to minimize fruit temperature and avoid the high latex flow that occurs very early morning.

3.1.2 Crates

Plastic crates are recommended as the field containers for exporting mangoes. They should have large ventilation holes to allow for air exchange to prevent excessive heat build up. They must be cleaned before use and free from any contamination such as sap or soil.

3.1.3 Holding fruit on farm

Harvested fruit should be held in clean and fully shaded areas to avoid sun exposure. If a shaded area is not available, crates should be covered with a light reflective covering such as a bed sheet. Fruit should not be held on the farm for more than 6 hours before transporting to the packhouse.

Figure 38: Harvesting mangoes on the farm

3.2 Records and Documentation

Records of the harvest date and time, and time of consignment to the packhouse.

4. Transportation Temperature Management

4.1 Transportation temperature management

Proper transportation of harvested fruit is important to maintain fruit quality. Stack crates neatly on transportation vehicles, preferably in a covered vehicle or covered with a light-colored reflective material.

Transport during cooler parts of the day and unload immediately upon arrival at the packhouse.

4.2 Packhouse procedures

After being received at the packhouse, fruits should be handled within 12 hours and kept at ambient temperature. Precooling should be avoided if there is no air conditioning in the packhouse to prevent fruit sweating and skin damage.

4.3. Load cooling

4.3.1 Before starting load cooling

To ensure proper functioning of cool rooms, it is important to organize commissioning and testing. The cool rooms must be calibrated to ensure accurate thermostat readings and a calibration certificate should be requested.

Figure 39: Cool room at a packhouse

4.3.2 Room cooling

Products should be widely spaced to increase surface area, with space provided in between stacks and between stacks and walls to allow air circulation. Cartons should be stacked neatly to avoid crushing boxes below.

4.3.3 Forces air cooling

Forced air cooling can quickly remove field heat from fruit, but requires proper infrastructure and management to avoid quality issues.

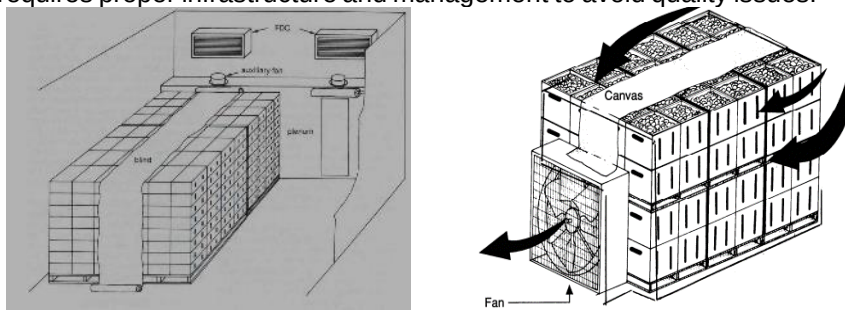


Figure 41: Forced air cooling system

4.4 Transporting to export hub and/or service providers

Refrigerated transport systems are designed to maintain the temperature of produce, and fruit must be pre-cooled to the set temperature before being transported to export hubs.

4.5 Carton design

Cartons or fiberboard boxes used for packaging mangoes must have adequate ventilation holes or be open top cartons with no lid to allow airflow across the fruit. The design of ventilation holes must provide good ventilation without compromising mechanical strength. Cartons must be of sufficient strength to withstand stacking, palletizing, transport, and high humidity, and must be made of a good grade of cardboard to ensure strength.

4.6 Phytosanitary treatments

4.6.1 Vapor heat treatment (VHT)

Pre-cooling of fruit should be avoided before VHT treatment, and transportation temperature should not be below 18°C if the fruit has to travel some distance to the VHT plant.

Forced air cooling is the preferred method to reduce the pulp temperature and for sensitive varieties, staggered cooling can be used. VHT treatments can accelerate ripening, so the fruit must be put into a cool chain after leaving the VHT facilities.

Figure 42: A VHT treatment system

4.6.2 Irradiation

Fruit to be irradiated should be pre-cooled and maintained in a cool chain after leaving the packhouse to maximize shelf-life. Irradiation facilities should have temperature management capacity, and maintaining the cool chain throughout the irradiation process is essential.

Fig 43: A Irradiation System

4.7. Export systems

4.7.1. Airfreight

Airfreight facilities often have limited cool room capacity, so it is important to cool fruit to 12-15°C and minimize breaks in the cool chain.

Airfreight utilizes air pallets or air containers with different capacities and ventilation levels.

Cargo holds are often set to low temperatures for transportation of ripe and irradiated mangoes.

4.7.2. Sea freight

Sea freight for exporting mangoes involves using refrigerated containers that can vary in size and atmospheric conditions. Temperature settings for containers depend on the variety, maturity, and distance to the destination. Loads should be cooled as close as possible to the set temperature before stuffing the container.

4.7.3. Road Freight

The fruit must be precooled before loading onto a truck, as the refrigeration systems in the truck do not have load cooling capacity. The truck should also be pre-cooled to the set temperature before loading. It is important not to switch off the refrigeration systems during transportation from the packhouse to the destination.

4.8. Post arrival management

Mangoes should be unloaded directly from the container or trailer onto a refrigerated receiving dock at the importer or Supermarket distribution center (DC) in order to maintain the integrity of the cold chain.

Fruit ripening maintain	18 to 22ºC.
Holding	12 to 15ºC
Distribution transportation at	12 to 15ºC or 5 to 8ºC

(for some mango varieties)

4.9. Non refrigerated temperature management systems

It is suggested to conduct harvesting in cooler parts of the day and protect the fruit from direct sunlight. Well-ventilated plastic crates that allow air movement should be used, and wet fruit should be dried quickly. Cooler parts of the day should be utilized for transporting the fruit

4.10. Conventional refrigerated systems

Conventional cooling systems are not very efficient at cooling large loads of fruit, and it is important to understand the cooling capacity of the system being used to prevent exceeding it.

4.11. Forced air systems.

Forced air systems that are designed to cool loads and not for storage purposes. It is important to ensure that the forced air system is designed correctly to deliver the required airflow without exceeding the cooling capacity of the refrigeration unit.

4.12. Calibrations

The accuracy of cooling system thermostats must be ensured through calibration at the beginning of the season, and regular checking is essential using accurate thermometers, fruit temperature probes, and wind speed measuring instruments. Equipment should also be sent to testing centers for verification once a year.

5. Managing The Ripening Processes

5.1. Fruit maturity

Fruit maturity affects chilling injury susceptibility. In general, chilling injury decreases as the fruit develops, matures and ripens. Thus, immature fruit are more susceptible to chilling injury than fruit undergoing ripening. It is important to harvest the fruit only when it has reached the appropriate level of maturity.

5.2. Managing the ripening process

To ensure a longer shelf life and better quality of mangoes during transportation, it is important to manage the heat produced during the ripening process. This can be achieved by maintaining cooler temperature settings and avoiding breaks in the cool chain.

5.3. Managing fruit respiration and CO_2 production.

Increases in temperature can increase the rate of respiration, which produces carbon dioxide (CO_2). High levels of CO_2 can affect fruit quality and pose a hazard for cool room operators. CO_2 levels must be managed in the cool chain and maintained below 1%.

5.4. Managing Ethylene Production

Mangoes produce relatively low levels of ethylene but are sensitive to exogenous ethylene applications. It is necessary to locate ripening rooms away from storage areas containing produce that could be damaged by exposure to ethylene. Pure ethylene gas is potentially explosive and extreme caution and appropriate safety measures must be in place for its use.

5.5. Determining Temperature

Many factors need to be considered at the stage of ripeness, current process being undertaken and the variety to determine what temperatures should be used.

Below 10^{o}C	Sea export only for green eating varieties.
10-12^{o}C	Sea export temperature and storage
12-16^{0}C	General transportation temperature
18-22^{o}C	Optimum Ripening temperature
Greater than 24^{o}C	Too warm

6. Occupational Health and Safety

Cool rooms require proper ventilation to manage CO_2 gas buildup from fruit ripening and safe handling of ethylene gas. Clear warning signs and safety procedures in Vietnamese and the common language must be provided.

SOP 5: Transportation Management for Export Mangoes

1. 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.

2. Packaging and Shipping Management.

2.1. Basket storage at the orchard

In mango export transportation management, the containers are very important and must ensure full compliance with technical specifications to ensure safety for the fruit and the transporter. The containers need to be cleaned with water and detergent after each use and must be dried before reuse

2.2 Transport from the orchard to the packing house

The transportation of mangoes for export can be done using motorcycles, tricycles, or small trucks. However, it is recommended to use tricycles or small trucks as they provide better stability. The vehicles must be in good condition, with appropriate licenses and registrations, and stable shock absorbers.

3 Temperature management

3.1 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. Transport the fruit during cool times of the day

Unload the fruit immediately upon arrival at the packing house. The fruit must be completely dry before it is moved to the packing house.

3.2 Packhouse

Store the fruit at room temperature before packing. Cooling the fruit before packing will cause excessive sweating and potential skin damage. If no cool rooms are available then fruit that has to be held for longer periods should not be used for export.

3.3 Vapor heat treatment (VHT)

Refer to **SOP No.4 Standard Operating Procedures for cool chain management of exported mangoes**.

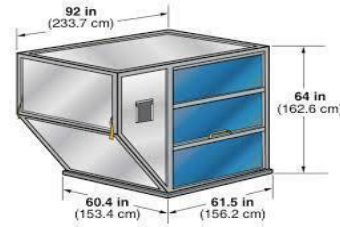
3.4. Irradiation

Refer to **SOP No.4 Standard Operating Procedures for cool chain management of exported mangoes**.

4. Exporting System

4.1 Air transport

There are two types of specialized transport vehicles being passenger planes and cargo planes. The air transportation system uses two cargo loading devices, the "pallet" and the "container". The fruits must be transported at the right ripeness to minimize the effects of temperature fluctuations.



4.2 Sea transport

The transportation of products by sea using refracted containers. These containers include standard containers, atmosphere-controlled containers, and gas-controlled containers. During shipment, the air flow will rise from the floor and must avoid large gaps between pallets and empty floor space.

Fig 46: Sea transport by sea

4.3 Sea transport – Controlled Atmosphere Container

The potential for the transportation of goods by sea using controlled atmosphere (CA) containers is huge. These containers can adjust CO_2 and O_2 levels to control temperature and relative humidity. The mangoes need to undergo gas creation before being placed in the container and adjusted to a normal atmosphere before being cooled for market consumption.

4.4 Land transport

When transporting goods by road, the fruits need to be pre-cooled before being loaded onto the truck, as the truck's cooling system cannot cool the cargo. The truck's cooling system must be turned on and maintained during transport, and the temperature setting will depend on the destination and cargo weight.

Fig 47: Land transport by truck

4.5 Delivery management at port

It is important to ensure that the mangoes are pre-cooled before loading onto the truck and kept at a temperature of 12°C to 15°C during the road transportation. Upon arrival at the port, the mangoes should be directly unloaded from the container or truck onto the receiving dock to maintain the integrity of the cold chain.

4.6 Cargo monitoring

Monitoring the products during transportation can provide valuable information on load performance and assist exporters in improving their systems. Shipping containers typically have monitoring systems, but access to data needs to be negotiated with the shipping company.

4.6.1 Sensor placement in the Container

During transportation, temperature sensors must be connected to a data logger in the container to store temperature data for hours. These sensors should be placed between pallets, in the middle of the boxes. Sensor placement must ensure that the sensor head does not penetrate the mango. At the destination port, the data can be read and analyzed without opening the container.

4.6.2 Data logger

When placing data loggers in shipping containers, it is important to clearly identify the location of containers containing the temperature data loggers for easy retrieval of data. Temperature sensors should be distributed across the containers from front to back and from top to bottom. This will make monitoring and temperature management easier and more accurate.

5. Health and safety

Drivers transporting mangoes from orchards or packing facilities must have valid licenses appropriate to the type of vehicle they are

operating. Packhouse employees must be trained in occupational health and safety, and equipment and facilities must be regularly inspected for safety. Smoking or lighting fires is prohibited within the packhouse and ripening rooms, which must be labeled with warning signs about CO_2 accumulation.

SOP 6: Traceability for Horticulture Operators

1. Principles of Traceability

1.1 Overview

The key elements of a traceability system are:

1. Identification of operators
2. Identification of products
3. Maintaining the integrity of batches

However, on its own a traceability system does not deliver added value unless the data is applied to the management of critical business conditions.

Additional key tools are required to ensure that the traceability system delivers meaningful improvements in product safety and quality:

4. Compliance data to be collected for each batch
5. Withdrawal and recall procedures

Finally, the traceability system involves collecting and managing data, which can provide logistical challenges as operators grow. As a result, there are significant advantages in using modern and standardized approaches to traceability data acquisition and management. Additional principles to be considered are therefore:

6. Use of international data standards for traceability

1.2 Principle 1: Identification of Operators

Operators in the supply chain, for which traceability systems are required, should each be identifiable by a unique code. Ideally the coding to be applied should be officially recognisable and be standardized across all operators in a supply system.

In the case of producers, larger scale farms may be divided into different production locations (plots) for traceability purposes. In this case there should be one identifier for each plot

Small farms may be clustered together for traceability purposes where they receive treatments in common.

The description of a traceability system for producers should define the spatial limits of the farm on a map.

1.3 Principle 2: Identification of products

1.3.1 Species and variety identification

Each species/variety should be identified by a code. If a GS1 Global Trade Item Number (GTIN) has been allocated, this should be used as the product identifier.

Figure 48: A Global Trade Item Number (GTIN) example

1.3.2 Date codes

A date code should be recorded, corresponding to the date of reception within each year.

1.3.3 Batch coding for farmers

All products produced by a farmer should be allocated a batch code to identify the batch.

A product record sheet should be generated for each batch code allocated, which shows the contain of relevant production information applicable to the code (see Principle 4).

1.3.4 Batch coding for distributors

All products received by a distributor, packer or exporter should be allocated a batch code on reception to identify the batch.

Products within a single batch code should, as far as possible, be homogeneous, notwithstanding the commercial need to split and combine batches.

Different batch codes should also be allocated where part of the production receives a different treatment whilst in the ownership of the operator

1.4 Principle 3: Maintaining the integrity of batches and batch data

1.4.1 Recording transactions between operators

The central aim of a traceability system is to ensure that there is a permanent and retrievable record of the transfer of identifiable batches between identifiable operators.

A secondary aim is to ensure that, as far as possible, the integrity of data relating to a batch received by a distributor is preserved.

Thus, where a consignment containing several batches is transferred between two operators, the consignor should inform the consignee of the batch codes which have been applied during his

operations. The Collection agent should allocate a separate batch code to each batch of product from different farms, and transfer this information to the packhouse, linked to each physical batch of product delivered.

The codes should be recorded by the consignee, who should seek to preserve the integrity of these batches throughout his operations.

1.4.2 Managing batch separation and mixing

Products which are allocated different batch codes should be kept separate throughout the time it is in possession of the operator, to allow the final product to be marked with the code which identifies the supplier.

Therefore, as far as possible, products from different batch codes should not be mixed.

Boxes of products with different batch codes should be labelled with a temporary label to distinguish them from each other.

Where a consignment from a single supplier contains several batches identifiable by codes, then each of these batches could be provided with the receivers' batch codes. Where this would result in too many batches to allow efficient handling and batch separation, then batches from a single supplier may be combined. Where this is the case, it is recommended that:

- the number of batches mixed is kept to a minimum
- if batch mixing is necessary, then the priority should be to mix products from a single supplier.
- when batches are mixed, the records for both batches record:
    - The batch number of the product with which the product is mixed
    - The quantity of the of the product which is mixed

1.4.3 Identification of batches in the final product

The final product should be physically labelled with relevant information, including batch code, to ensure that:

- The batch can be distinguished from other batches which may have the same appearance and with which they may be confused
- The supplier of the product in the box or crate is identifiable

Where products are packaged individually, each package should be marked on the label with the batch code applicable to the product which it contains.

The outer carton/box should be marked with the batch code applicable to the product which it contains, as well meeting additional labelling requirements of the destination market and client.

Batch codes and customer codes should be indicated on the sales documentation (invoice, packing list etc).

1.5 Principle 4: Generate and record relevant compliance data

1.5.1 Data recording for producers

The farmer should generate a batch code for each batch of production.

At the level of the farm the producer should ensure that the farm diary records all relevant farm data pertaining production to a batch, against the batch code(s) allocated to that batch.

The farmer should meet regulatory requirements for data collection and transmission. In particular, any requirements to maintain a farm diary to record relevant data should be observed.

1.5.2 Data recording for distributors

An operator receiving product from a producer, or a distributor should allocate a batch code for each batch of products, which identifies and characterises the batch.

All the relevant data concerning the treatment of that batch whilst in the possession of the operator should be recorded against the batch number.

The batch number is also used for stock control (intermediate and final product storage), as well for the recording of important process variables during product reception, intermediate storage, processing, and despatch.

All product and process records (including Hazard Analysis and Critical Control Points data) will be recorded and allow identification of the batches to which these conditions were applied.

It is important to note that should any part of the batch be treated differently from another part this should be considered as a splitting of the batch and a new batch code allocated.

1.6 Principle 5: Withdrawal and recall procedures

1.6.1 Conditions under which a withdrawal or recall procedure should be initiated

An operator will initiate the procedure under the following circumstances in respect of a batch of products which have already been consigned from the operator:

- When instructed by the CA

- When results from official controls or internal controls indicate that there is a significant risk that the products consigned are either
    - unsafe for human consumption; or
    - do not comply with regulatory conditions
- When results of internal controls communicated by customers indicate that the products consigned are either
    - unsafe for human consumption; or
    - do not comply with regulatory conditions

1.6.2 Communication with consignees

All consignees to which affected batches (defined by batch codes) have been consigned should be notified in writing.

The operator will notify consignees which have received the affected batches of products

1.6.3 Withdrawal and recall action to be taken by the receiver.

The withdrawal/recall notice should clearly state the actions to be taken. The actions to be taken should be selected based on ensuring that unsafe or non-compliant products are not placed on the market.

In cases where the batch or items from it have been sold onto other commercial operators, those operators should also be informed in the same way.

1.6.4 Recall procedure

A decision to undertake a recall will be made when the following conditions are in place:

a) Unsafe or non-compliant products are known to have been sold to final consumers

b) There is a probability that some of the product remains unconsumed

In cases where any operator which has handled a batch of products becomes aware these conditions are in place and that it should be recalled, he should inform the Competent Authority without delay.

The responsibility for the decision to launch a product recall will be with the Competent Authority.

The Competent Authority will specify the conditions of the recall, including naming the operator responsible for implementing and coordinating the recall, including funding its costs.

1.7 Principle 6: Use of international traceability data standards

1.7.1 Application of the GS1 Global Standard

In Vietnam the traceability requirements for fruit and vegetable crops are set by TCVN 12827:2019 “Traceability - Requirements for supply chain of fresh fruits and vegetables”. This requires the application of the GS1 Global Standard. This standard must therefore be applied in the design of the database and application.

Operators should therefore apply coding systems under GS1 according to the requirements of applicable national regulations and standards.

1.7.2 GS1 Company prefix

The GS1 Company prefix will be allocated by the Ministry of Agriculture and Rural Development (MARD).

Note that at the time writing the MARD is considering the precise coding to be used in the agricultural sector. MARD will inform the operator of the correct GS1 Company Prefix to be applied.

For existing operators, the GS1 Company prefix will be allocated on the launch of the system by MARD.

For new operators this will be issued by MARD on approval of applications for registration

1.7.3 Global Location No.

Each operator will also be allocated a unique Global Location Number (GLN) which defines the location. GLN will be a unique identifier for the farm

The Producer Unit Code and the Packhouse Code may form the GLN

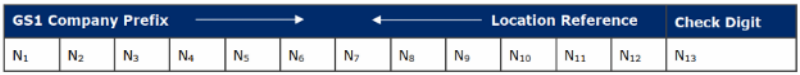


Figure 49 : Global Location Number Component

1.7.4 Global Trade Item No.

Each product/crop combination will be allocated a Global Trade Item No. (GTIN) by the MARD. This will be variety specific

- The GTIN for each species/variety is made up by GS1 Prefix plus crop/variety codes.
- The GTIN codes should be used to identify the type of products concerned.

1.7.5 Serial Shipping Container Code

The Serial Shipping Container Code (SSCC) identifies the batch number of the specific consignment.

It incorporates the GS1 Enterprise code with a sequentially allocated batch nos. to identify the batch.

Figure 50: A Serial Shipping Container Code example

1.7.6 Use of standardized traceability software packages

The operator may use any traceability software package which meets the requirements of the legislation.

At the present operators have the choice of several different packages, all of which apply the GS1 data standards.

However, operators should also bear in mind that the MARD and the Numbering and Barcode Centre of the Directorate for Standards, Metrology and Quality (STAMEQ) are also developing software packages (e.g., farm diary) for agricultural operators.

Operators should be aware that due to this level of specificity, the use of such official packages may be mandatory in future.

1.7.7 Labelling and reading traceability data.

A major challenge is the linking of traceability data to physical products. It implies the need for a system which makes labelling of physical products, and subsequent reading of the data. An operator may choose to apply and transmit codes in plain text. Standardized data tools have been developed to meet this need.

EAN Bar coding standard

An alternative approach is to use variable optical or electronic systems for writing and reading traceability data.

Operators should use the International Article Number (also known as European Article Number or EAN) standard for the barcode and numbering system. This is subsumed in the GS1 Global Trade Item Number standard. Other symbologies such as QR codes and RFID codes can represent additional characters. They are also standardized.

Operators should therefore consider the efficiency of recording, transmitting, and reading traceability data, by investing in the appropriate printing and reading equipment.

MANGO EXPORT MARKET REQUIREMENTS MANUALS

1. Introduction

Vietnam exports mangoes to more than 15 countries, with China as the largest market (80% of exports). USA, Russia, Korea, Japan, Hong Kong, and Australia are also significant markets. Each has specific mango requirements, including quality and MRLs, and their own quarantine rules.

Vietnamese mango export markets fall into three categories: "phyto markets" like Korea, requiring VHT for fruit flies, others need phytosanitary certificates confirming pest-free consignments, and "open markets" like Hong Kong/Singapore with no treatment requirements.

Vietnam, a signatory to the IPPC, supports science-based quarantine measures to prevent pest spread via mango imports.

2. Markets and requirements

Requirements fall into two categories:

- Regulatory Requirement
- Customer Requirement

Phytosanitary Certificates

Many importing countries require proof of the pest-free status of the produce or other information about the product, such as treatment. Some countries will only accept an electronic phytosanitary certificate.

Specific Regulations of Import Markets

Importing countries from protocol markets require that exporters and their supplying farms be registered. While some countries where market access has been negotiated and include a phytosanitary treatment may require the presence of inspectors from the importing country during the treatment process., others may delegate local inspectors and have periodic audits of the procedures.

Country	Status	Country	Status
Australia	Protocol market Table 2	Malaysia	Phyto certificate
Bahrain	Phyto certificate	New Zealand	Protocol market Table 2
Canada	Open	Qatar	Phyto certificate
China (People's Republic of China)	Protocol market Table 2	Papua New Guinea	Open
EU	Phyto certificate	Russia	Phyto certificate
Hong Kong	Open	Saudi Arabia	Protocol market
Japan	Protocol market	Singapore	Open

	Table 2		
Korea South	Protocol market Table 2	UAE	Phyto certificate
Kuwait	Phyto certificate	UK	Phyto certificate
Macau	Phyto certificate	USA	Protocol market Table 2

3. Specific Requirement Of Import Markets

3.1 Korea

Means of Conveyance

Air cargo or ship cargo (except for hand luggage or parcel post)

Registration of Export Orchards and Packinghouses (Including Vapor Heat Treatment (VHT) Facilities)

- Orchards producing fresh mango fruits for export to Korea and packinghouses shall be located in the delta area of Mekong River and registered with and be supervised by the NPPO of Vietnam annually.
- Export orchards shall be sanitized, managed and supervised based on GAP

Sorting and Packing

The fresh mango fruits exported to Korea shall be sorted and packed only in packinghouses registered with PPD.

The sorting process of mango fruit for export must include brushing, washing with water and dipping

Vapor Heat Treatment (VHT)

The fresh fruits of mango for export to Korea shall be vapor-heat-treated using saturated vapor

Export Inspection and Certification

- The export inspection shall be carried out jointly by the Korean and Vietnamese plant quarantine inspectors, on over 2% samples of the entire carton.
- Consignments that passed the export inspection shall be managed separately from those that were rejected or that were not inspected in order to prevent cross contamination of pests.
- Consignments that passed the export inspection shall be stored and managed until their arrival in Korea in order to prevent recontamination by contaminants such as pests and soil.

Packing and Labeling

- Packinghouses for the fresh fruits of mango, which were vapor heat treated, shall be equipped with insect-proof facilities and be regularly undergone disinfection.

- Each packing carton of the fresh fruits of mango that have been passed by an export inspection shall be sealed, using the methods (including sticky tape, sticker or label) approved by PPD.
- The label “For Korea” and “the names (or registration numbers) of orchards and packinghouses” shall be marked outside the export packing cartons or pallets of palletized cargo.

3.2 Australia

General Information

Orchards must have a registered PUC code, Packhouses and treatment facilities must be registered to supply to Australia

Regulations for All Shipments

Exporters must present a valid Import Permit for Mangoes prior to the commencement of each phytosanitary inspection.

Copies of verified treatment data relevant to the consignment shall be sent with each phytosanitary certificate.

Fruit to Be Sourced From Registered Orchards/Blocks Free From Specific Pests

Mangoes exported to Australia must be sourced from registered PUC orchards/blocks free of the following pests:

- Sternochetus gravis - mango pulp weevil

Packaging and labeling requirements

Each consignment of goods must be packed in clean and new packaging.

Mangoes must be made insect proof according to the department's secure packing options, prior to being irradiated and exported.

Phytosanitary Treatment:

Fresh mangoes must undergo mandatory irradiation at an approved treatment facility.

Currently VHT and Hot water are not accepted.

Pesticides and Maximum Residue Levels (MRLs)

The Australian Pesticides and Veterinary Medicines Authority (APVMA) registers and approves all agrochemicals and veterinary drugs and establishes MRLs for these substances based on GAPs and GVPs. All information can be checked at

https://www.legislation.gov.au/Details/F2020C00473

3.3 Japan

General Information

Mango fruits Mangifera indica (Variety: Cat Chu) produced in Vietnam.

Phytosanitary Treatment

- No other species but Mango (Variety: Cat Chu) are mixed in fresh fruits subject to the disinfestation treatment for exportation to Japan.

- Volume of disinfectant is within the limit of absorption rate in the running test.

Packaging and Labeling Requirements

- After being treated, fresh fruits are cleaned and sorted again before being packed and loaded into carton boxes. The carton boxes must have ventilation holes and nets to prevent insects as regulated by Japan.
- Packaging and labelling for the export of mangoes to Japan must meet the following conditions:
    - Packaging cartons must be new and clean and made from either new or recycled materials.
    - Packaging cartons must include Growing Area Code (PUC), Processing Facility Number (TFC), Packer Number (PHC), Pack Date, Lot Number,

General Requirements

- Packages are properly labeled as per mutual agreement (clearly seen that they are treated and are to be exported to Japan).
- Packages have indication of destination “FOR JAPAN”
- Each package or bundled package is sealed with 3 labels which are provided by PPD at 3 positions (top, bottom and side of the package)
- Indication of completion of export certification

Pesticide Control

Under the provisions of the Food Sanitation Act, Japan has established maximum residue limits (MRLs) for various compound forms of chemicals and agricultural supplies. A list of permitted substances and MRLs for agrochemicals in food can be found at: http://db.ffcr.or.jp/front/.

3.4 EU

Packaging and Labeling Requirements

Carton labelling in most countries is a legal requirement. Each carton or tray must have the information visible externally

General Requirements

- A phytosanitary certificate will only be authorized by a PPD officer provided that export conditions are met.
- For sea freight shipments, both the container and seal numbers must be recorded on the phytosanitary certificate.
- The registered packhouse PHC/ must be entered in the phytosanitary certificate
- Name of the VHT treatment facility, time and temperature shall be indicated in the treatment section of the phytosanitary certificate.

Pesticides, Contaminants and Maximum Residue Levels (Mrls)

The European Union has set maximum residue levels (MRLs) for pesticides and other contaminants, such as heavy metals, in and on food products. Products exceeding the MRLs are withdrawn from the market. For substances that are not yet included in the European regulation, the default MRL applies, which is 0.01

It is important to check the database for allowable pesticides regularly as the information is regularly reviewed and changed the site

- https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en It is also important to check the MRL levels regularly
- https://food.ec.europa.eu/plants/pesticides/maximum-residue-levels_en

Heavy Metals:

Lead contamination in mango must be below 0.10 mg/kg and cadmium below 0,050 mg/kg.

Biological Contaminants

E.coli contamination must be below 100 cfu/g. Having two out of five samples up to the 1000 cfu/g limit is still acceptable.

Salmonella in cut fruit must be absent throughout their shelf life, at least in five samples of 25 g.

3.5 USA

General Information

Restricted Ports: Hawaii, Puerto Rico or any of the territorial waters of the United States are restricted for mango imports.

Inspections: Commodities must be inspected at the port of entry in accordance with 7 CFR § 319.56-3.

Regulations for All Shipments

- A valid import license issued by USDA is required for each shipment
- Exporters must present a valid Import Permit for Mangoes prior to the commencement of each phytosanitary inspection.
- Copies of verified treatment data relevant to the consignment shall be sent with each phytosanitary certificate.

Fruit to Be Sourced From Registered Orchards/Blocks Free from Specific Pests

Mangoes for export to USA must be sourced from registered PUC orchards/blocks free of the following pests:

- *Macrophoma mangiferae - Macrophoma rot*
- *Xanthomonas campestris pv. mangiferaeindica* - Bacterial black spot
- *Sternochetus mangiferae* - Mango seed weevil

Packaging and Labeling Requirements

Packaging and labelling for the export of mangoes to USA must meet the following conditions:

- Packaging cartons must be new and clean and made from either new or recycled materials.
- Packaging cartons must Growing Area Code (PUC), Processing Facility Number (TFC), Packer Number (PHC), Pack Date, Lot Number, stamp with the words "Treated by irradiation" or "Treating with radiation" and the international radura symbol.
- Palletised consignments must have handling facility code (TFC), handler identification number (TIN), and the date of processing
- Un palletised consignments must have individual cartons displaying handling facility code (TFC), handler identification number (TIN), and the date of processing

Pesticides and maximum residue levels (MRLs)

The Food and drug administration (FDA) monitors the level of pesticide chemical residues in domestic and imported foods to ensure that they do not exceed the EPA limits or tolerances

Detailed information on the requirements and maximum residue levels can be found on the website below and the appendix:

- https://www.fas.usda.gov/maximum-residue-limits-mrl-database
- https://www.epa.gov/pesticide-tolerances
- https://www.ecfr.gov/

3.6 China

Regulations for All Shipments

- Exported mango batches to the Chinese market must have traceability of origin and packaging facility codes, as well as cultivation area codes (cultivation area codes are a necessary and mandatory requirement) approved by the Ministry of Agriculture and Rural Development and the General Administration of Customs of China (GACC).
- Currently, all mango batches imported into the Chinese market do not require irradiation treatment or VHT
- Fresh mangoes exported through official channels to the Chinese market must comply with China's regulations on plant quarantine and food safety.

Packaging and Labeling Requirements:

- Packaging: The product packaging must bear the words "For export to China" and clearly state the following basic information in either Chinese or English:
    - Product name, country of origin, quantity, weight
    - Cultivation area code

    - Packaging facility code (identification number/code)
- Packaging: It must comply with import regulations, including the use of packaging materials made of wood treated according to the ISPM 15 standard.
- Labeling: Origin traceability labels can be affixed to the fruits or printed on the outside of the packaging boxes. The labeling should include the following information: exporting organization's name, fruit variety, cultivation area name and registration code, packaging facility name and registration code.

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