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GLOBAL QUALITY AND STANDARDS PROGRAMME

SIAEP

STANDARD OPERATING PROCEDURES

For Exported Mangoes Field Practices

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Disclaimer

Contents

Acronyms

GAP	Good Agricultural Practices
GlobalG.A.P	Global Good Agricultural Practices
HACCP	Hazard Analysis and Critical Control Points
IPM	Integrated Pests Management
MRL	Maximum Residual Limit
MSDS	Material Safety Data Sheets
pp	Plant protection
PPE	Personal Protective Equipment
PUC	Production Unit Code
SOP	Standard Operating Procedures
TCCS	Standard Base
VietGAP	Vietnamese Good Agricultural Practices
HACCP	Hazard Analysis and Critical Control Points
IPM	Integrated Pests Management

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1. Scope of SOP Document

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. Key Definitions

GAP (Good Agricultural Practices) are principles and procedures established to ensure a safe and clean production environment, food must ensure that it does not contain pathogens such as biological toxins (bacteria, fungi, viruses, parasites, etc.). microorganisms) and chemicals (pesticide residues, heavy metals, nitrate content), protect the health of producers and consumers as well as protect the environment.

HACCP (Hazard Analysis and Critical Control Points) is a systematic preventive approach to food safety from biological, chemical and physical hazards in production processes that can cause the finished product to be unsafe and designs measures to reduce these risks to a safe level.

IPM (Integrated Pest Management) combines the use of biological, cultural and chemical practices to control insect pests in agricultural production.

The components of an IPM in a mango production are:

- Cultural practices (such as pruning)
- Biological control (Encouraging beneficial)
- Physical exclusion (e.g. fruit bagging)
- Monitoring, (determine pest thresholds)
- Chemical control (Based on pest thresholds, whilst minimizing damage to beneficial
- Careful application of chemicals with well calibrated equipment

MRL (Maximum Residual Limit) is the maximum amount of pesticide residue that is expected to remain on food products when a pesticide is used according to

label directions. The MRL is not a toxicological parameter, but rather a trading standard set by national and international authorities (e.g. Codex Alimentarius) to ensure that residues are controlled in world food trade.

PHI (The Preharvest Interval) is the minimum time from the last pesticide treatment until the product is harvested (to ensure the product is safe from pesticide residues). PHI has units of date and is indicated on the pesticide packaging (label).

Traceability is the ability to follow the movement of a food through specified stage(s) of production, processing, and distribution". The central objective of a traceability system is to ensure that there is a permanent and retrievable record of the transfer of identifiable batches between identifiable operators.

MSDS (Material Safety Data Sheets) is a form of text containing data related to the properties of a particular chemical. It is designed to provide those who need to be exposed to or work with chemicals, whether long-term or short-term, of safe working procedures or necessary handling measures when affected.

PPE (Personal Protective Equipment) includes work wear, safety glasses, safety helmets, etc. or other equipment designed to protect workers' bodies from work-related injuries. Personal protective equipment will protect you from external hazards such as physical, electrical, thermal, chemical, disease or air pollution.

PUC (Production Unit Code) is an identification number for a growing area in order to monitor and control production and control harmful organisms; traceability of agricultural products.

SOP (Standard Operating Procedures) is a document that describes routine activities related to investigative quality. The purpose of an SOP is to perform operations correctly and always go the same way.

VietGAP (Vietnamese Good Agricultural Practices) is a local Vietnamese farm assurance program, translating customer requirements into Good Agricultural Practice.

Floral Induction is the practice of artificially inducing a floral event through the use of cultural practices and chemical applications.

3. Introduction

The document is intended to assist producers meet the requirements of export markets, which is the delivery of consistent quality fruit that meets product specifications and standards; meets shelf-life expectations, produced within the MRL limits of the importing countries while complying with all regulatory, health, safety and environmental standards.

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

- SOP No.2: Standard Operating Procedures for export mangoes packing house
- 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: Manual s for mangoes export market requirements.

4. 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 and peel colour. It also influences 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.

Harvest maturity is one of the components of fruit quality, especially in the commercial context. In order to ensure that the fruit is of good quality and has a long circulation time in the market, it is necessary to collect the right ripeness according to each market or use purpose (Do Minh Hien, 2006) [13].

Equipment and containers will influence the amount of cross contamination from sap, disease and abrasion damage.

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.

5. Tree Management

5.1. Orchard Establishment

5.1.1. 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
- Tuong Da Xanh (Taiwan)

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.

Seedlings must conform to regulations with the following morphological requirements:

- **Rootstock and Roots**: The rootstock must be in good health, free from pests and diseases, straight stem and root neck, with the bark not damaged. Rootstock diameter (measured 2 cm below the graft) from 1.2 to 1.7 cm or more; The graft site must be seamless and well integrated; The root system is well developed “not twisted”, with presence of root hairs.
- **Stems, Branches and Leaves**: Stems are straight and solid; The apical leaves are mature, green, and have a characteristic shape and size of the variety; Having 2 layers of leaves (leaf stalks) or more; Seedling height (from the surface of the potting medium to the top of the shoot) from 60 to 80 cm; The diameter of the graft (measured about 2 cm above the graft) is 1 cm or more.
- **Purity, Uniformity, Pest and Age**: The tree must be exactly the same as the name; The degree of difference in seedling morphology does

not exceed 5% of the number of seedlings. Trees must be healthy and free from pests and diseases. Planting age after grafting of 4-5 months.

- **Specifications for Nursery**: Black nylon gourd, firm, intact gourd; Diameter and height respectively 14 - 15 x 30 - 32 cm.
- **Number of Drainage Holes/Pot**: There are usually 20 - 30 holes, hole diameter 0.6 - 0.8 cm, the medium must be full of nursery pots.

5.1.2. 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.

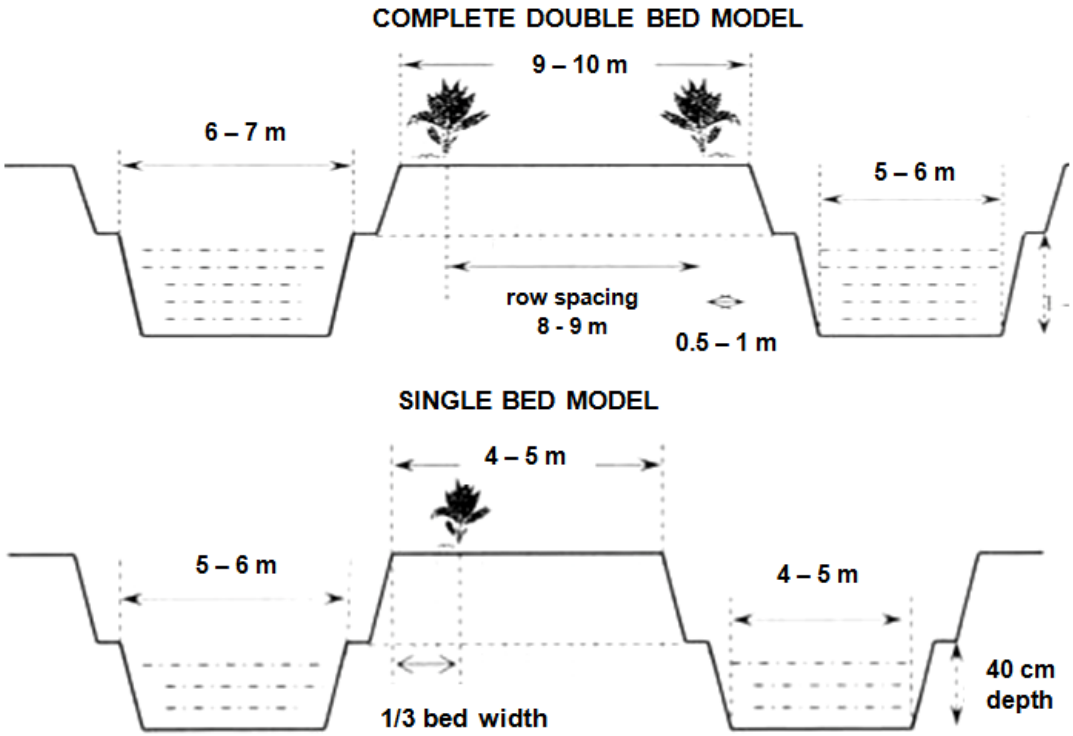


Figure 1: Modelling of types of beds

In highland and mountainous areas: planting holes, length x width x depth 0.8m x 0.8m x 0.6m. Under poor soil conditions larger holes may be required such as 1m x 1m x 0.8m. The planting hole should be pre-prepared 2 - 4 weeks before planting. Apply basal fertilizer 10-20kg of organic fertilizer and 0.2kg of NPK or 0.5kg 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.

Place the tree upright in the middle of the hole backfill to the root neck, compacting soil around the tree. After planting, surround the base of the tree with mulch such as straw or dry grass. Water regularly to keep the plant moist for the first month.

5.1.3. Planting Density and Spacing

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. Currently, planting densities are 6 x 5 m or 6 x 6 m, equivalent to 277-333 trees/ha, these can then be thinned once trees become too large. Traditional plantings for Cat Chu and Cat Hoa Loc are 7 x 7 m or 8 x 8 m.

5.2. Pruning

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.

5.2.1. Structural Pruning

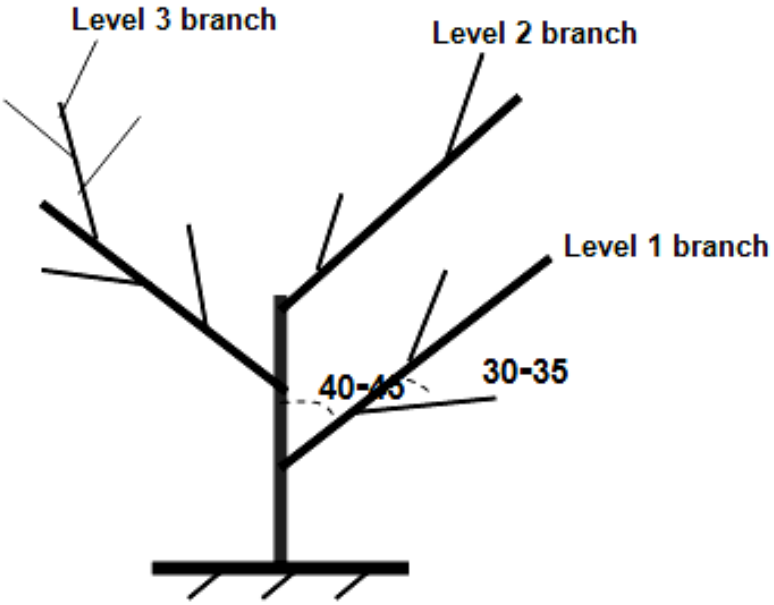


Figure 2: Creating a canopy at the basic construction stage

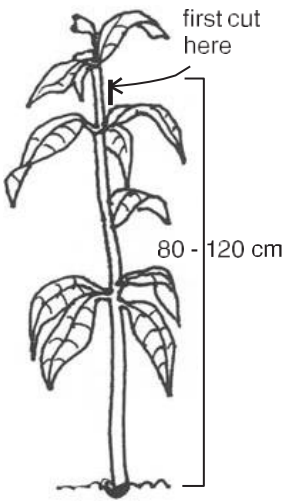


Figure 3: Cut the buds after planting

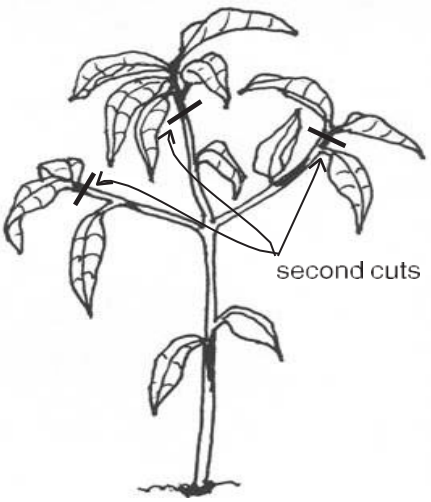


Figure 4: Choose 3 buds to make level 1 branches

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.

5.2.2. Maintenance Pruning

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 to improve light penetration in the canopy, maintain canopy size, synchronises growth flush, removal of dead and diseased wood.

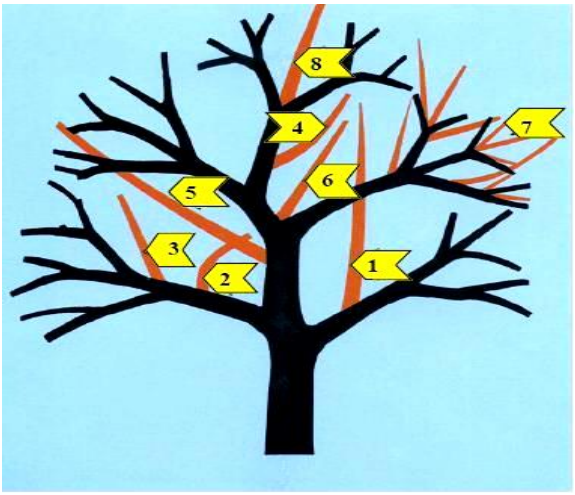


Figure 5: Maintenance pruning

5.2.3. Rejuvenating Older Trees

Removal of all the branches, leaving only the main frame will encourage strong growth flushes.

5.2.4. Hygiene

Remove all pruned branches from underneath the tree from the orchard. Clean and disinfect pruning equipment between trees to avoid cross contamination.

5.2.5. Tools Required

Tools required secateurs and/or pruning shears, pruning saw, alcohol 70% or Sodium hypochlorite for sterilizing equipment.

5.3. Irrigation

5.3.1. Water Quality

The quality of irrigation water and water used for production must comply with current standards, ensuring that there is no risk of chemical and biological

contamination. Every year, it is necessary to assess the risk of pollution in order to take remedial measures. (Refer to Decision No. 84/2008/QD-BNN dated on July 28, 2008, by the Minister of Agriculture and Rural Development at Appendix 3: Testing indicators and assessment guidelines).

5.3.2. Water Application

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 frequently flooded areas, dykes must be built to prevent floods and pump out water to keep the water level stable in garden ditches at least 0.6 m from the surface. Helps protect the roots well, the roots do not rot due to waterlogging.

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.

Tree Ages		Water Demand (Litres/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

Providing adequate water at critical growth phases flowering, fruit development and post-harvest flush is essential to maximise productivity of the tree.

When designing a large-scale garden, it is important to note the following points:

- Near water resource, convenient for mechanisation.
- Crop water usages.
- Drainage
- Combination of the irrigation network with traffic, paying attention to easy irrigation and drainage.

5.4. Crop Development

5.4.1. 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 flowering in a period where heavy rain is likely to occur.

Figure 6: Time of treatment with PBZ

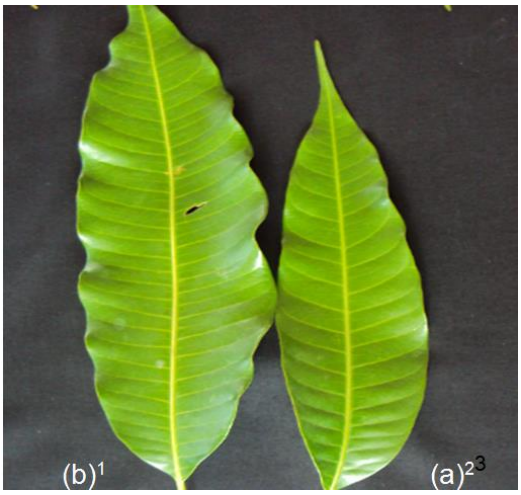


Figure 7: Leaves 1 month after PBZ treatment

5.4.2. 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.

5.5. Training Requirements

Farmers and workers need to be trained in orchard establishment, pruning, irrigation practices, floral induction chemical application. Technical staff and extension officers, workers need to be fully trained in mango growing techniques according to VietGAP standards.

5.6. Records and Documentation

The following items are needed in this section:

- Records of planted varieties, sources.
- Soil test results.
- Map of the farm layout.
- Water testing results.
- Farm diary for applications of chemicals and fertilizers, including rates, dates and method of application, spray operator, any additives and chemical batch number.
- Bagging dates of fruit.

6. 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.

Once trees are bearing, the timing of fertiliser applications is as important as the quantity applied. Vegetative growth should not be encouraged at the expense of flower and fruit production. Too much fertiliser at the wrong time can also affect fruit quality.

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.

6.1. Soil Type

Mango can be grown on many different soil types; however, the preferred soils are well drained loam and sandy soils, with a water level of no more than 2.5m. Mango is suitable for soil with a pH of 5.5 - 7. Soils below pH <5 plants will

restrict the availability of nutrients to the plant and will need applications of lime to raise the pH.

6.2. Monitoring

6.2.1. Observations

Nutrient management can be monitored by visual inspection, based on leaf and fruit manifestations for nutrient deficiencies such as phosphorus, potassium and other trace elements. Calculating nutrient removal by crop yield is a good indication of needed volumes of application

Nutrients taken in every ton of mango (MIK)	
Nutrient	**Quantity (g)**
N	845
P	180
K	1285
Ca	1150
Mg	240
B	2
Zn	2
Fe	6

Table 2: Nutrients removed per ton of fruit

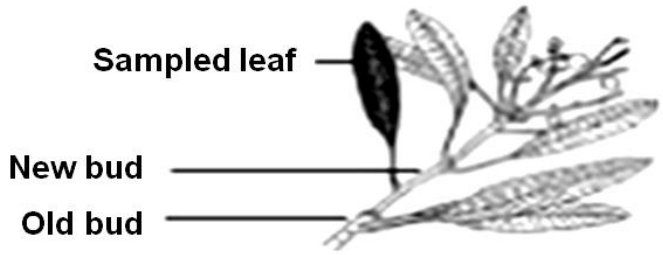
This is the amount of nutrients removed permanently from the soil, which will need replacing.

6.2.2. 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.

6.2.3. 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



Select the sampled leaf location for analysis

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Figure 8: Leaf sampling location

6.3. Analysis Results

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 3: Analysis results of leaf samples

6.3. Application

6.3.1. Young Trees

Fertilizer application is done only when the trees have shown signs of growth and the 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

6.3.2. 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 4: Recommended dosage of fertilizer

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Trees will require nutrition 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.

6.3.3. Products

Use fertilizers on the list of permitted business in Vietnam.

There are six main types of fertilizers:

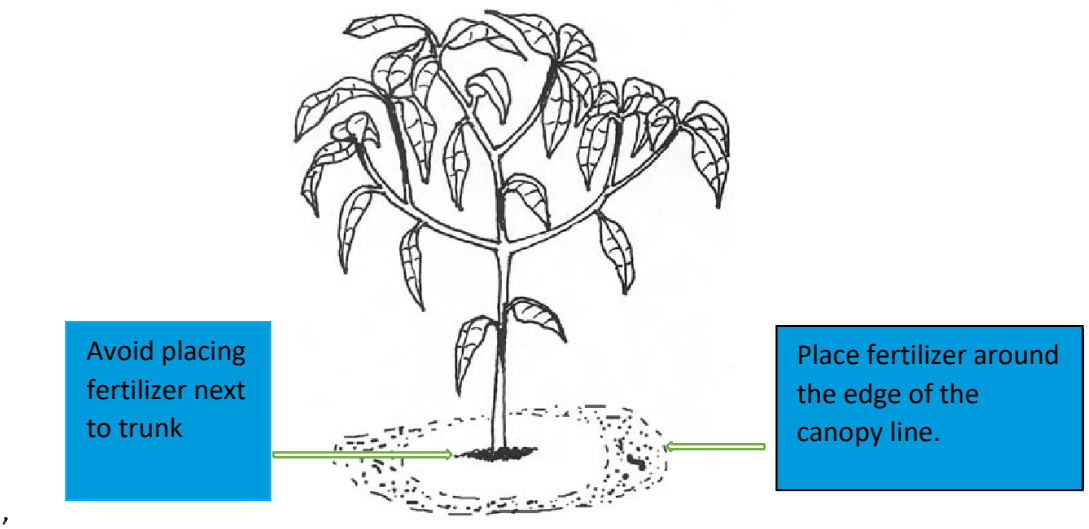
- Straight (e.g. Urea)
- Blend
- Compound (NPK)
- Soluble straight (e.g., Liquid ferts)
- Liquids (Chelates)
- Organic (e.g. Manures)

All inorganic products should be labelled with the nutrient composition. All products should be free from contaminants such as chemicals, biological substances or heavy metals.

6.3.3. 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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6.4. Storage

6.4.1. Storage Conditions

Fertilizers should be kept away from direct sunlight, rain and/or moisture (to avoid forming lumps and dust); in a clean environment; free from dust/dirt; below 30˚C (some fertilizers are sensitive to high temperature).

6.4.2. Managing Stored Fertilizer

Do not store fertilizers in bulk which are incompatible near each other e.g. urea and ammonium phosphate fertilizers. Keep lime and fertilizer well separated. Phosphate fertilizers are less affected by humidity conditions, but fertilizers that contain nitrogen (N) or potassium (K), including mixtures thereof, are more hygroscopic in wet conditions, so they should be stored in a dry and ventilated place.

Fertilizer granules that have been physically degraded and/or contain fines will absorb moisture faster than non-degraded product. This can lead to product setting. In general terms P fertilizer can be stored for longer periods than NPK blends or mixtures of compounds.

Fertilizers should never be stored with liquid fuels.

6.5. Hazards

There are a number of hazards associated with fertilizer usage: Contamination of product, avoid using non label inorganic fertilizers only by buying from reputable suppliers. Organic fertilizers are at high risk for biological

contamination; therefore, they should only be applied to the soil, but never to the tree canopy or fruit.

Protecting equipment such as gloves, dust masks should be used when handling fertilizer.

Over fertilization can be a significant environmental risk such as soil contamination, ground and surface water contamination as well as increase greenhouse gasses.

6.6. Waste Management

Places for mixing and storing fertilizers and additives are constructed and maintained to ensure a minimal risk of contamination of production areas and water resources.

Any old or contaminated fertilizer must be disposed of in accordance with local regulations.

6.7. Training Requirements

- Training of farmers, advisers and extension officers in developing nutritional programs.
- Undertaking risk assessment.
- Training of farmers in fertilizer handling and application practices.
- Training of farmers in fertilizer requirements and evaluation of products.

6.8. Records and Documentation

Methods and results of risk assessment of chemical, biological and physical contamination that may contaminate products from the use of fertilizers and additives are recorded and kept on file. Farm diary for applications of chemicals and fertilizers must include rates, application dates, method of application, any additives and chemical batch number. Maintain soil sample analysis results.

7. Pest and Disease Management

7.1. Weed Management

Weeds interfere with growth and development of plants by competing for nutrients and moisture. They can potentially harbor pests and diseases. In addition weeds also interfere with the fruit picking, tree pruning and other horticultural

operations like hoeing and irrigation. Some weed species may also pose a quarantine risk to an importing country.

Maintaining ground cover down the tree rows is beneficial especially for limiting water runoff and erosion.

7.1.1. Identification

Identification of weed species is important to be able to assess whether weeds are potential hosts for pests or diseases, a beneficial substitute for nitrogen fixation or as a host for beneficial insects. The correct identification will enable the selection of an appropriate control method.

7.1.2. Products

Use only herbicides approved for use in Vietnam (limited use of this method). The product must also be approved by the importing country. Consult with Plant Protection Department and Exporters.

7.1.3. Applications and Equipment Requirements

Methods of weed control are as below:

- Hand weeding
- Mechanical method
- Cover cropping
- Chemical control

Use manufacturer's label rates for mixing and application. Chemical control will require a knapsack sprayer; spray nozzles must be cleaned after use. Triple rinse knapsack sprayer after use.

7.1.4. Hazard Management

When performing the work of mixing and spraying, the operator is required to wear gloves, boots, masks and glasses to ensure labor safety. When spraying, the sprayer directs the nozzle to the bed on the right hand side to avoid entering the sprayed area. Avoid spraying against the wind direction. Wash hands thoroughly after spraying.

7.2. Insect Pest Management

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

7.2.1. Pest Identification

Accurate identification of pests is critical for meeting quarantine protocols and correct management strategies/key pests of mango in Vietnam. That is documented in Field identification guides.

(Refer to [5], [7] and [9]*).*

7.2.2. Pests of Quarantine Concern

These are pests that importing countries may have specific restrictions on farms. Owners have to prove they do not have these pests or they applied adequate controls in place to ensure they will not be present in export products.

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.

(Identification symptoms, development conditions and prevention measures. Refer to [5], [7] and [9]).

7.2.3. Other Significant Pests

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*)

(Identification symptoms, development conditions and prevention measures: Refer to [5], [7] and [9]).

7.2.4. Pest Monitoring

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

The monitoring process is to:

- Take random samples of pest numbers in the orchard.
- Count the pests and beneficials collected.
- Record pests and beneficials numbers and stage of development.
- Equipment required Pest and beneficial identification guides, hand lens 10X magnification [5, 7 and 8].

7.2.5. Pest Thresholds

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.

Suggested thresholds are:

- Scale > 5% of fruit and 10% of leaves have a live scale.
- Mango hoppers on one or more branches are infested pre- flowering.
- More than 5% of leaves are infested mites.

7.3. Disease management

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

7.4. 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 (fruit flies, mealybugs and fruit borers). 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.

7.4.1. Bag Specifications

Bags need to be made of durable and water-proof materials, white or yellow color (bag color will influence skin color) with a size of 21 x 32 cm.

7.4.2. Bagging Process

Bagging process should apply at 30-45 days after fruit set, spray with fungicide prior to commencement of bagging. Remove weak or poorly developed fruit and leave only 1 fruit and 3-4 fruits per stem for Hoa Loc and Cat Chu mango, respectively. When the fruit bag is attached, ensure the opening of the bag is neatly closed around the stem of the fruit to form cover preventing water from coming into contact with the mango. The fruit bag will limit the number of chemical sprays from 5-7 times/crop, help maintain skin quality, reduce fruit fly, contributing to better quality, increase profits, reduce environmental pollution and lower residue of pesticides on fruit.

Figure 9: Types of fruit bags and fruit packaging techniques

7.5. Chemical Management

7.5.1. Products and Registrations

Use only registered, and licensed chemicals. Follow the table of promulgation of the list of pesticides permitted to be used and banned from use in Vietnam.

Some products may not be authorized in the importing country, so they cannot be used on crops specified for export. It is important for the exporter to provide a list of such substances.

7.5.2. Application of Chemical Interventions

Always use chemicals strictly according to instructions on labels or instructions of competent state agencies.

The label or product information sheet below should be observed and recorded in writing:

- Warning signage
- Safety directions
- Recommendations for additives and warnings of product incompatibilities
- Storage and mixing instructions

The following information and the information in section 7.9 should be recorded in a spray diary:

- Commercial product name
- Active ingredient
- Batch number and expiry date.
- Identification of treated zones
- Application rates and registrations

Owners of farms should be aware that counterfeit products are circulating in the industry and should only purchase from reputable licensed suppliers.

7.5.3. Material Safety Data Sheets (MSDS) Requirements

MSDS contain information on the physical, chemical and taxological properties of the compound as well as health effects, precautions and emergency procedures.

An MSDS should be supplied at the point of purchase and kept readily accessible on farms or places where chemicals are being stored and used [1].

7.5.4. Managing Resistance

- Choose a pesticide that minimizes the impact on beneficial organisms.
- Minimizing pesticide use is fundamental to pesticide resistance management.
- Use protective bagging,

- Tank mixes, avoid combinations (mixes) of 2 insecticides in a single application.
- Rotate usage chemical groups.
- Avoid persistent chemicals.
- Use long-term rotations.

7.5.5. Managing MRL's

- Check to see if the importing countries MRL differs from the one set in Vietnam.
- Chemical applications must be used according to the instructions on the product label.
- Do not exceed spray applications
- Ensure that spray equipment is correctly calibrated
- Adhere to withholding periods on labels.
- Record all spray applications.

Set a plan in place to regularly check the implementation of the manufacturing process and take samples to check for chemical residues in the product at an accredited or designated testing laboratory. Analytical results of chemical residues do not exceed the maximum limit according to regulations. Set action levels to ensure product complies with MRL limit at point of sampling for regulatory compliance (typical action limits are 1/3 to 1/2 of the MRL).

7.6. Chemical Storage

The storage, arrangement, preservation, use and handling of chemicals are carried out according to the guidelines by the Department of Plant Protection [1].

7.6.1. Storage Areas

Chemical warehouses are periodically checked to remove expired or banned chemicals in accordance with the regulations. Storage facilities are to be well ventilated and have a solid sealed floor with surrounding lip so any spillages can be contained. A spill cleanup kit should be readily available. Storage area should be lockable to prevent unauthorized access. Liquid fuels, oil and chemical fuels should be stored separately in suitable facilities.

7.6.2. Storage Containers

Check containers regularly for signs of rust or leakage and transfer contents to another container only, if necessary, when replacing the chemical packaging and container, write the full name of the chemical and instructions for use such as the original packaging and container. Never decant chemicals into food or drink containers.

7.6.3. Spill Cleanup Equipment

A clean up kit consists of bin, shovel broom absorbent material e.g. sand and a bag of hydrated lime.

7.7. Chemical Safety Procedures

Use personal protective equipment (PPE) that meets label and MSDS guidelines.

Before opening the product, read the label for safety of mixture and loading, follow label guidelines, work in well ventilated areas. Do not stir chemicals with hands or arms. Triple rinse all used containers and equipment.

Read labels of pesticides carefully, wear PPE, check equipment for leaks, avoid eating, drinking or smoking during mixing, spraying and clean-up operation. Ensure equipment is accurately calibrated, observe weather conditions especially wind speed and direction.

After application clean all equipment, ensure runoff is captured, make people aware of re-entry periods of the sprayed areas

Dispose of chemicals and packaging according to state regulations.

7.8. Training Requirements

Farmers, farm workers and extension officers are required to have training in the basics of pest/beneficial identification, pest monitoring, pest thresholds, methods of control.

Training program includes chemical usage, types of chemicals, managing resistance, spray calibration, effective application, chemical safety and managing MRL’s.

7.9. Documentations and Record Keeping

The following items should be involved in this section:

- Document of pest occurrences, dates and numbers observed.
- Training records
- Record keeping of spray applications in a spray diary (date, rates, product, batch number, timing and weather conditions).
- Recordkeeping of chemicals stored on farm (product, batch numbers and expiry dates).
- Recordkeeping a copy of MSDS sheets for chemicals being used.

8. Harvest Procedures and Practices

8.1. 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 regard to maturity as it will affect its transportation and sale potential, it is therefore very important to harvest fruit at the right maturation stage.

8.1.1. 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.

8.1.2. 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.

8.1.3. Internal Attributes

Once mature the internal flesh colour of the fruit will turn a light butter colour (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.

8.1.4. 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 (%) = $[(W_2 – W_0) \times 100]/(W_1 – W_0)$

Where: W_0 = petri dish weight (g), W_1 = fresh weight of the sample (g),

W_2 = in the dry matter of the sample (g).

8.1.5. 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.

8.2. 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 the National Standard: TCVN12827:2019 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 TCVN12827:2019 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)

8.3. 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 these times will vary as some markets will require more advanced maturity

8.3.1. 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.

8.3.2. 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 broken stem needs to be kept separate to avoid cross contamination.

8.3.3. 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.

8.3.4. 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.

8.3.5. 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.

8.3.6. 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.

8.4. Training Requirements

Employees are trained in fruit maturity, sap management, harvesting, preliminary processing, traceability requirements, product packaging, transportation, loading and unloading operations and bookkeeping.

8.5. Documentations and Record Keeping

- Fully records of the diary of harvesting and selling products have to meet GAP or VietGAP regulations.
- Record keeping and internal audits are in place.
- The location of each production batch must be specified.
- When the product is shipped, record of sale time, buyer name and address, and a record of each batch is kept together.

9. Compliance and Record Keeping

9.1. Mandatory Legislative Requirements

9.1.1. Registrations

Producers who wish to supply for export are required to register for a Producer Unit Code (PUC) with the Plan Protection Department. The conditions for award of the PUC and set out in Sectoral Standard TCCS: 774:2020/BVTV.

Importing market authorities may require additional conditions applied to the suppliers. For example, direct property registration and inspections which are documented in the existing protocols involved in the Plant Protection Department.

9.1.2. Standards

Standards comprise qualities, technical and other requirements of the target export market.

9.2. Customer Requirements

While without regulatory requirements many customers will require a level of compliance from their suppliers before they purchase their products.

9.2.1. Certifications and Accreditations

Most modern retail markets in importing countries will require GlobalGAP or equivalent HACCP based on accreditation.

Depending on the importing customer, some fewer requirements can be accepted; therefore, customer and exporter will negotiate with each other.

9.2.2. Registrations

Some accreditation systems will require the producer to become a registered supplier.

9.2.3. Audits (Internal and External)

Most accreditation systems will require an internal and an external audit. The external audit must be conducted by an approved audit company.

9.3. Occupational Health and Safety

Referring to Decree No. 39/2016/NĐ-CP for Detailed provisions on implementation of some articles of occupational safety and sanitation law, this section will include the items below:

- Assessment of health and safety risks to workers.
- Identification of hazards related to workers health and safety.
- Development of guidelines to reduce the hazards that had indicated.
- Insurance of the safety of the worker by providing a safe working equipment, training on safety knowledge in the use of chemicals and pesticides for workers.

9.4. Environmental Management

Based on the Law on Environmental protection No. 55/2014/QH13, Article 69: Environmental protection in agricultural production, farmers must follow local Environmental regulations. Some main of them are:

- Chemical storage, use, handling and disposal are carried out according to VietGAP guidelines.
- Develop the documented system in place to minimize the risk of contaminating the environment including chemical, fertilizer, heavy metal and biological contaminants.
- Do not graze livestock that pollute the soil and water sources in the production area. Set up measures to treat waste to ensure that it does not pollute the environment and products after harvest.
- Develop a waste removal program to meet local regulatory requirements.
- Complete records of all above said activities.

9.5. Training Requirements

- Training in HACCP principles.
- Accreditation training VietGAP, GlobalGAP, internal auditing.
- Training in developing risk assessment plans.
- Instruction to staff for monitoring, recording and keeping the related documents.

9.6. Record Keeping

9.6.1. Regulatory Requirements

The farm operator is obliged to use any nationally mandated software package for the keeping of farm records, and traceability, to ensure that record keeping is compatible with national data standards. The farm operator will maintain production and process records for a period of one year and make available for inspection by regulatory officials. The farm operator will maintain records in regard to market access requirements such as registrations, inspection and audit results.

9.6.2. Compliance Requirements

The farmers are required to keep all records related to the farming process for VietGAP and/or GlobalGAP certification, including farm layout maps, copies of certificates, chemical and fertilizer application records, risk assessments on food, environment, health and safety hazards, records of internal audits, result analysis of water and fruit, records of training and traceability. Calibration and internal auditing records are maintained for at least 3 years.

Other document requirements need fully documenting the origin of varieties and rootstocks purchased.

9.6.3. Other Records

Other records are:

- A display of clear signs for access areas and written instructions for workers/persons to follow when entering and leaving.
- Records of contracts/agreements with packers/exporters.
- Records on pest, dates, monitoring levels and damage observed.

10. Relevant publications

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