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Mango Export Guide

KNOWLEDGE FOR LIFE

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Members of the Mango Technical Working Group



MINISTRY OF INVESTMENTS, TRADE AND INDUSTRY
State Department for Trade





















KENYA EXPORT
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List of abbreviations and acronyms

AFA-HCD	Agriculture and Food Authority – Horticulture Crops Directorate
APHA	Animal and Plant Health Agency
BRCGS	Brand Reputation Compliance Global Standards
BTB	Black Twig Borer
BTOM	Border Target Operating Model
DEFRA	Department for Environment, Food & Rural Affairs
EU	European Union
FCDO	Foreign, Commonwealth and Development Office (UK)
FPCK	Fresh Produce Consortium of Kenya
FPEAK	Fresh Produce Exporters Association of Kenya
GRASP	Risk Assessment on Social Practice
HACCP	Hazard Analysis and Critical Control Points
HCD	Horticultural Crops Directorate
HO	Harmful Organisms
IPPC	International Plant Protection Convention
KEPHIS	Kenya Plant Health Inspectorate Service
LOD	Limit of Detection
MEL	Monitoring, Evaluation, and Learning
MoA	Ministry of Agriculture
MRF	Monitoring & Results Framework
MRLs	Maximum Residue Limits
NPRMF	National Pesticide Residue Monitoring Framework
PCPB	Pest Control Products Board
PIT	Project Implementation Team
PRA	Pest Risk Analysis
PSC	Project Steering Committee
RASSF	EU Rapid Alert System for Food and Feed
REDIT	Regional Economic Development for Investment and Trade
SASA	Science and Advice for Scottish Agriculture
SDT	State Department for Trade
SMEs	Small and Medium-Sized Enterprises
SMETA	Sedex Members Ethical Trade Audit
SOPs	Standard Operating Procedures
SPS	Sanitary and Phytosanitary
TMA	TradeMark Africa
TWG	Technical Working Group
UK	United Kingdom
WTO	World Trade Organization

Introduction

Fresh mangoes remain a key fruit for both domestic and export from Kenya. in 2024, the value of fresh mangoes was at KES 14.1 billion, export value of USD 16 million in 2023, thus providing livelihood to over 200,000 mango value and other value chain actors. To avoid an official EU ban, in 2014, Kenya implemented a voluntary ban on fresh mango exports due to high levels of fruit fly infestation (*Bactrocera dorsalis*) and non-compliance with phytosanitary standards. In 2020, the UK officially exited the EU to date, very few fresh mangoes have been exported to the UK despite the difference in SPS requirements, including on *Bactrocera dorsalis*.

Through the Regional Economic Development for Investment and Trade (REDIT) Programme, supported by the UK Foreign, Commonwealth and Development Office (FCDO). TradeMark Africa is supporting the enhancement of Kenya's Horticultural Market Access through Risk-Based SPS Compliance, Systems Approaches, and Sustainable Pest Management.

Centre for Agriculture and Biosciences International (CABI) though the Technical Assistance to Enhance Kenya's Horticultural Market Access through Risk-Based SPS Compliance, Systems Approaches, and Sustainable Pest Management funded by TMA has supported the Mango Technical Working (TWG) members see table 1 for the members and their affiliated institutions) to develop this Mango Export Guide for use by farmers, nursery service providers, growers, aggregators, packhouse quality control team, exporters and other service providers such as packhouse, transporters, and spray service providers.

Table 1 – List of Mango Technical Working Group Members and affiliated institutions

Name	Position	Institution
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1.Mango Production and Export Market

1.1. Mango varieties grown in Kenya

Mangoes are the second most important fruit, contributing to 21% of the total value of fruits produced, compared to bananas, which contribute 32% of the total value. Approximately 65,870 Ha is under mango production, producing 736,662 metric tons (HCD, 2024). The Horticultural Crops Directorate (HCD) ranks the top 10 producing counties by value as Makueni (30%), Machakos (23%), Kilifi (16%), Kwale (8%), Meru (4.5%), Embu (2.8%), Bungoma (2.1%), Tana River (1.8%), Elgeyo Marakwet (1.1%) and Murang'a (1.1%), see table 1 for the top 10 mango producing counties in Kenya and Fig 1.

Table 2 – Mango production in Kenya

Type	2022			2023		
	Area (Ha)	Volume (Tons)	Value (KSHs)	Area (Ha)	Volume (Tons)	Value (KSHs)
National Fruits	225,525	4,214,620	86,262,986,161	233,695	4,241,602	111,677,741,264
National Mango	66,235	758,374	13,614,234,325	65,870	736,662	16,546,054,799
Makueni	22,422	245,367	3,614,947,000	19,904	199,626	5,988,781,101
Lamu	7,000	78,000	1,003,200,000	12,544	161,799	5,726,954,998
Kilifi	8,974	153,931	2,355,240,000	6,762	40,339	960,465,000
Tana River	2,486	39,292	1,081,440,000	3,715	65,305	893,050,000
Machakos	2,782	24,046	656,625,000	2,646	37,093	884,665,000
Siaya	2,550	19,531	674,310,000	2,130	21,055	639,921,520
Elgeyo Marakwet	965	20,000	463,600,000	676	23,400	520,500,000
Kwale	1,956	20,250	390,220,000	2,262	22,080	428,062,200
Kitui	2,651	13,255	293,575,000	3,132	15,963	310,110,000
Murang'a	932	11,555	203,684,735	950	13,523	304,341,437

Source: HCD, 2024

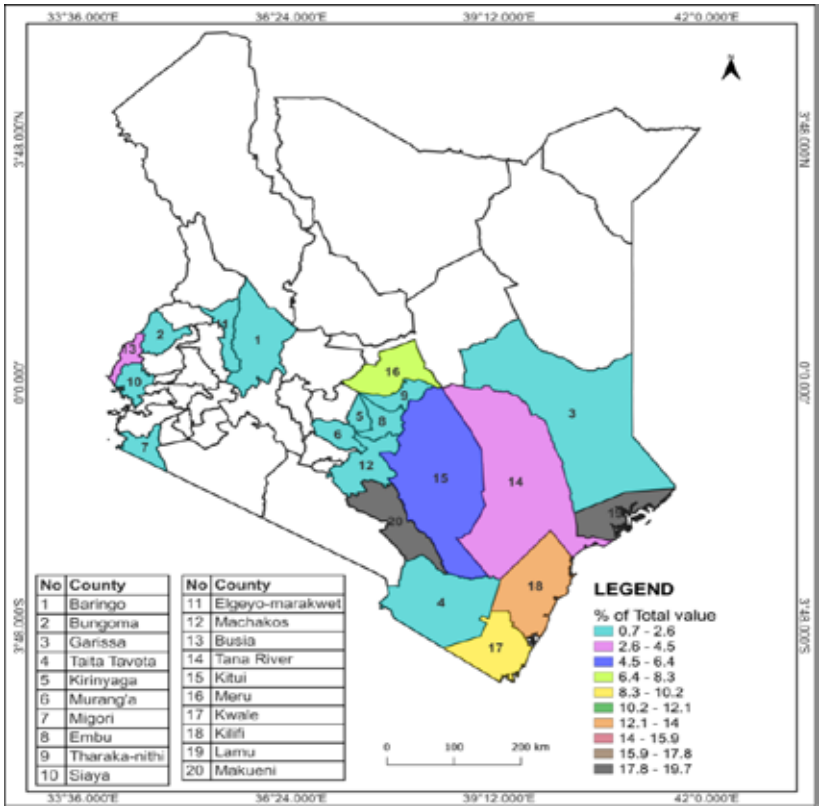


Figure 1-Mango production countries in Kenya
Source: KALRO

1.1.1 Mango varieties grown in Kenya for the international market Export

The main varieties are Apple, Ngowe, Kent/Keitt, Tommy Atkins. Tommy Atkins is the most exported due its excellent shelf life with good transportability. UK importers and consumers prefer non-fibrous mango varieties, such as Keitt, Kent, and Alphonso (CBI, 2024). Recently, fresh apple mangoes were exported to UK and their demand is growing.

The Alphonso mango variety is relatively new to Kenya, with only a limited number of orchards established so far due to limited seedling supply. Kenya is the only supplier of apple mango with the export season starting in November , ending March, see Table 4 Global mango annual export patterns. Table 5 below lists the main varieties grown in Kenya and their characteristics and Table 6 shows the various mango varieties, their maturity and harvesting period in Kenya.

Table 4 – Global Mango annual export patterns

Country of Origin	Transport	Variety	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Brazil	Air	Kent												
	Sea	Palmer												
	Sea	Tommy Atkins												
	Sea	Keitt												
	Sea	Kent												
Peru	Air	Kent												
	Sea	Kent												
Côte d'Ivoire	Air	Kent												
	Sea	Kent												
	Sea	Keitt												
Mali	Air	Kent												
	Air	Valencia/ smith												
	Sea	Kent												
	Sea	Keitt												
Burkina Faso	Air	Kent												
	Sea	Kent												
Guinea Bissau	Sea	Keitt												
Senegal	Air	Kent												
	Sea	Kent												
Mexico	Air	Kent												
Dominican Republic	Sea	Keitt												
Puerto Rico	Sea	Keitt												
Israel	Air	Aya												
		Maya												
		Omer/ kasturi												
		Shelly												
		Kent												
	Sea	Omer/ kasturi												
		Shelly												
		Kent												
		Keitt												
Pakistan/India	Air	Alphonso												
Pakistan/India	Air	Totapuri												
Pakistan/India	Air	chaunsa												
Spain	Road	Tommy Atkins												
		Irwin												
		Osteen												
		Kent												
		Keitt												
Kenya	Air/Sea	Apple												
		Kent												
		Keitt												
		Tommy Atkins												

UK International Development

Table 5 – Different Mango varieties grown in Kenya and their characteristics. *(Adapted from OECD 2012.)*

Variety: Keitt



Production

Ecological requirements

- Performs well in ecological zones (4-6)
- Well-drained sandy loamy soils (rich in organic matter)
- Soil PH of 5.5- 7.5
- Rainfall range between 400mm – 1200mm
- Mostly grown in Makueni, lower Murangá, Machakos, Embu, Meru, Elgeyo Marakwet,Tana River, Taita Taveta, Kilifi, and Kwale

Maturity Period

- Matures 75- 150 days from flowering depending on the ecological zone
- Seasons open from late December to April

Time to Bearing

- Grafted trees produce fruit in 2-3 years, lasting over 30 years.
- After 30 years, trees are topworked to increase productivity, ease management, and prolong the lifespan

Fruit characteristics

- Large, oval to oblong
- Smooth, thick skin, staying firm when ripe
- Remains dark green even when fully ripe, sometimes with a faint pink blush
- Bright yellow, firm, juicy, with a sweet tart Flavours and minimal fiber
- Ideal for slicing, salads, salsas and commercial processing due to its late season
- Long shelf life

Variety: Ngowe



Photo credit: Courtesy of AFA-HCD

Production

Ecological requirements

- Performs well in ecological zones (4-6)
- Well-drained sandy loamy soils (rich in organic matter)
- Soil PH of 5.5- 7.5
- Rainfall range between 400mm – 1200mm
- Mostly grown in Makueni, lower Muranga, Machakos, Embu, Elgeyo Marakwet, Tharaka Nithi, Meru, Kitui, Taita Taveta, Kilifi, Kwale, Kwale, Mombasa, Makueni, Embu, Elgeyo Marakwet, Murangá and Machakos

Maturity Period

Maturity Period

- Matures 75- 150 days from flowering, depending on the ecological zone
- It is mid-season to late season, usually January to March
- Early season mango variety October-February

Time to Bearing

- Grafted trees produce fruit in 2-3 years, lasting over 30 years
- After 30 years, trees are topworked to increase productivity, ease management, and prolong the lifespan

Fruit characteristics

- Large, oval and distinctly curved (beak shaped)
- Smooth skin with a prominent ventral shoulder
- Pale green with dark red blush on 30-80% of fruit surface
- Pale yellow, tender, juicy and sweet with minimal fiber texture
- Excellent for fresh consumption, juices, dry and processing
- Susceptible to anthracnose disease
- Long shelf life

Variety: Apple



Photo credit: Meshack Mulinge – The Mango Association of Kenya (T-MAK)

Production

Ecological requirements

- Performs well in ecological zones (4-6)
- Well-drained sandy loamy soils (rich in organic matter)
- Soil PH of 5.5- 7.5
- Rainfall range between 400mm – 1200mm
- Performs well in the coastal and semi-arid regions of Kenya. This variety grows well in Makueni, Machakos, Embu, Meru, Kilifi, Kwale, Taita Taveta

Maturity Period

- Matures 75- 150 days from flowering depending on the ecological zone
- It is a mid-season variety, usually from December to March/April, depending on the rainfall season

Time to Bearing

- Grafted trees produce fruit in 2-4 years, lasting over 30 years
- After 30 years, trees are topworked to increase productivity, ease management, and prolong the lifespan

Fruit characteristics

- Small to medium, distinctly rounded and globular, closely resembling an apple
- Smooth, waxy, and unblemished skin with a regular, classic form
- Base colour of green maturing to a bright, even yellow-green, often with a light pink or red blush
- Pale yellow, exceptionally crisp and juicy when ripe(like a pear or apple)
- Primarily for fresh, out of hand snacking (less messy), fruit salads, garnishes and as a crisp culinary element
- Long shelf life, delicate when ripe

Variety: Van Dyke



Production

Ecological requirements

- Performs well in ecological zones (4–6)
- Well-drained sandy loamy soils (rich in organic matter)
- Soil PH of 5.5–7.5
- Rainfall range between 400mm – 1200mm
- Performs well in warm sunny climates in highland and lowland regions of Kenya. It grows well in Makueni, Embu, elgeyo Marakwet, Murangá Machakos, Meru, Kilifi/Kwale

Maturity Period

- Matures 75 – 150 days from flowering depending on the ecological zone
- It is a mid-season variety, December to February

Fruit characteristics

- Small to medium, oval with a symmetrical attractive shape
- Very smooth, waxy skin with a classic mango silhouette
- Striking red blush over a bright yellow background
- Yellow, firm, sweet and flavorful with fibre
- Valued for its visual appeal in gift boxes and fresh fruit salads; good export variety
- Long shelf life

Variety: Tommy Atkins

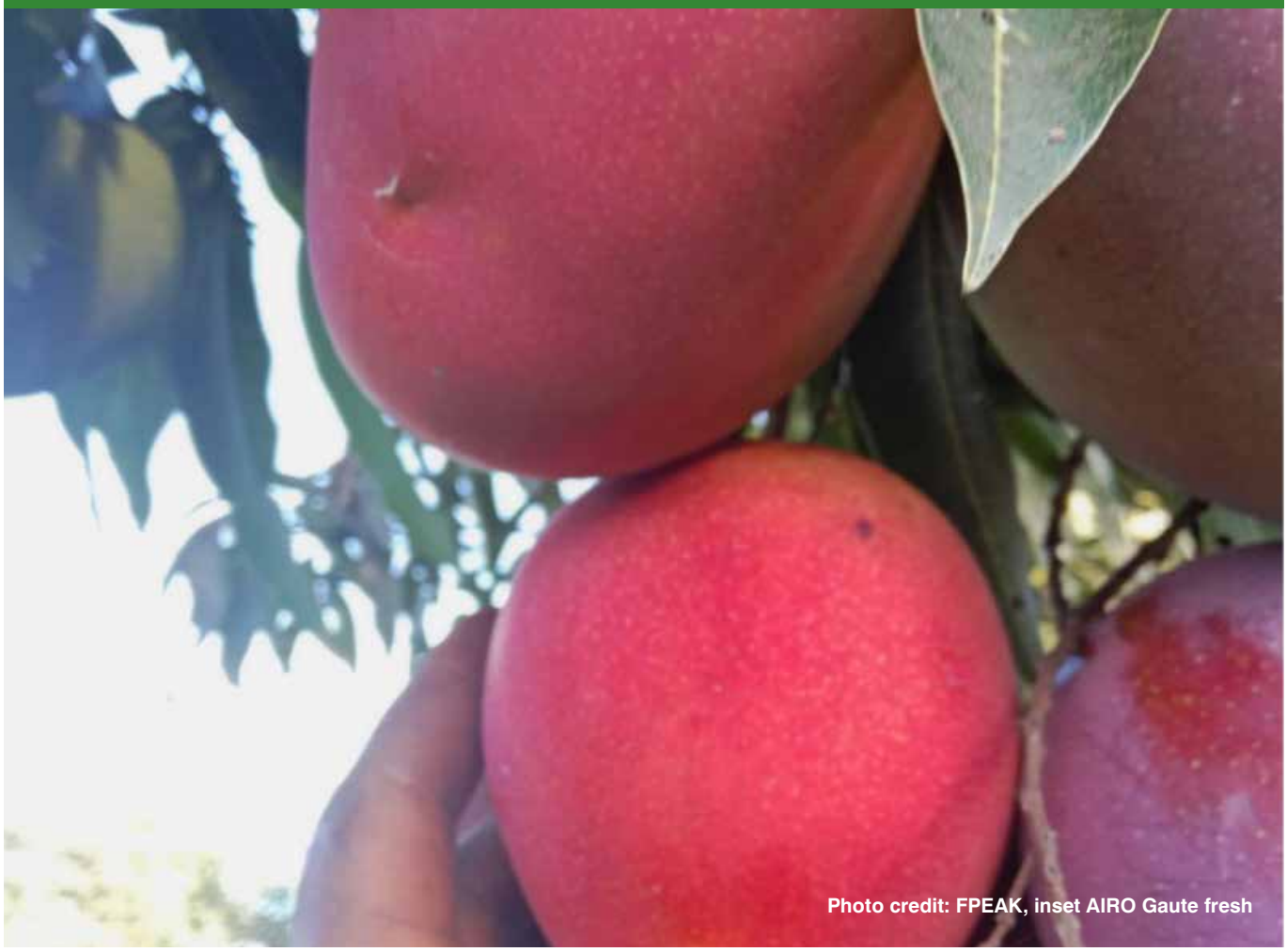


Photo credit: FPEAK, inset AIRO Gaute fresh

Production

Ecological requirements

- Performs well in ecological zones (4–6)
- Well-drained sandy loamy soils (rich in organic matter)
- Soil PH of 5.5–7.5
- Rainfall range between 400mm – 1200mm
- Performs well in warm climates with moderate rainfall mostly in Makueni, Murangá, Machakos. Embu, Kirinyaga, Elgeyo Marakwet, Kilifi and Kwale

Maturity Period

- Matures 75- 150 days from flowering depending on the ecological zone
- Mid-season variety, November- March. It has an excellent shelf life with good transportability

Time to Bearing

- Grafted trees produce fruit in 2–3 years, lasting over 30 years
- After 30 years, trees are topworked to increase productivity, ease management, and prolong the lifespan

Fruit characteristics

- Medium to large oval elongated
- Tough, thick skin, making it very resilient
- Vibrant mix of orange -red, purple and green
- Yellow to orange, moderately sweet, somewhat fibrous
- Primary commercial variety for shipping; used in juices, frozen products and fresh export
- Long shelf life

Variety: Alphonso



Production

Ecological requirements

- Performs well in ecological zones (4–6)
- Well-drained sandy loamy soils (rich in organic matter)
- Soil PH of 5.5–7.5
- Rainfall range between 400mm – 1200mm
- Performs well in the coastal and semi-arid regions of Kenya. This variety grows well in Makueni, Machakos, Embu, Meru, Kilifi, Kwale, Taita Taveta

Maturity Period

- Matures 75–150 days from flowering depending on the ecological zone
- It is a mid-season variety, usually from December to March/April, depending on the rainfall season

Time to Bearing

- Grafted trees produce fruit in 2–4 years, lasting over 30 years
- After 30 years, trees are topworked to increase productivity, ease management, and prolong the lifespan

Fruit characteristics

- Oval to oblong, often with a distinct central dip
- Smooth, thin skin with a small, flat stone
- Vibrant golden yellow skin, often with a red blush
- Deep saffron yellow, buttery, creamy and completely fibreless
- Premium fresh eating, desserts, pulps and luxury products
- Medium shelf life

Table 6 – Different Mango varieties grown in Kenya their annual harvesting periods

Mango Variety	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Keitt												
Kent												
Apple												
Ngowe												
Van Dyke												
Tommy Atkins												
Alphonso												

1.2. Mango Export Requirements

Fresh mangoes (species *Mangifera indica* L., family Anacardiaceae) quality requirements are commercial quality standards developed to promote quality fresh mango production, facilitate international trade, improve profitability, and protect consumer interests. The fresh mangoes quality standards have been developed overtime and harmonised by the United Nations Economic Commission for Europe (UNECE), STANDARD FFV-45 Concerning the marketing and commercial quality control of MANGOES (UNECE, 2023), and the Organisation for Economic Co-operation and Development, *Mangoes*, International Standards for Fruit and Vegetables (OECD, 2012), Codex Standard for Mangoes *(CODEX STAN 184-1993)* (CODEX, 2005).

The above UNECE, OECD are harmonised to the CODEX Standard on Mangoes; *CODEX STAN 184-1993*. Kenya fresh mangoes exports to international markets must comply to Kenya standards for fresh mangoes (KS EAS 329:2017) that's is harmonised to the CODEX *Mango STAN 184-1993* and the EAS 329: 2017 2 – Specification 2 Fresh mangoes – Specification. The above quality standards refer to fresh mangoes and do not apply to green preserving mango and mango processing. The fresh mango export quality requirements are summarised below.

1.2.1 Quality Requirements

Minimum quality requirements

In all classes, subject to the special provisions for each class and the tolerances allowed, the mangoes must be:

- intact/whole
- firm
- sound; produce affected by rotting or deterioration such as to make it unfit for consumption, is excluded
- clean, practically free of any visible foreign matter
- fresh in appearance
- practically free from pests
- free from damage caused by pests affecting the flesh
- free from black stains or trails which extend under the skin
- free from marked bruising
- free from damage caused by low temperature
- free of abnormal external moisture, excluding condensation following removal from cold storage
- free of any foreign smell and/or taste
- if present, it shall not be longer than 1.0cm

Maturity requirements

The development and state of maturity of the mangoes must be such as to enable them to continue the ripening process and to reach a satisfactory degree of ripeness. The colour of mature/ripe fresh fruit may vary according to variety, see Fig 2 below. The mature fresh mangoes must be able to:

- ensure a continuation of the maturation process until they reach the appropriate degree of maturity corresponding to the varietal characteristics
- withstand transportation and handling
- arrive in satisfactory condition at the place of destination



Illustration: Mature fruit allowed
Source: Mangoes | OECD



Illustration: overripe fruit- not allowed
Source: Mangoes | OECD

Figure 2 – Maturity requirements for fresh mangoes

Classification of fresh mangoes

Mangoes are classified in three classes, as defined below:

(i) "Extra" Class

Mangoes in this class must be of superior quality. They must be characteristic of the variety.

They must be free from defects, except very slight superficial defects, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package.

(ii) Class I

Mangoes in this class must be of good quality, see Fig 3. They must be characteristic of the variety.

The following slight defects, however, may be allowed, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package:

- a slight defect in shape
- slight skin defects due to rubbing or sunburn and suberized stains due to resin exudation (elongated trails included) not exceeding 3, 4, 5, 6 cm2 for size groups A, B, C, D respectively
- slight bruising
- scattered rust-coloured lenticels
- a yellowing of green varieties due to exposure to direct sunlight, not exceeding 40 per cent of the surface of the fruit, excluding necrotic stains

(iii) Class II

This class includes mangoes that do not qualify for inclusion in the higher classes but satisfy the minimum requirements specified above.

The following defects may be allowed, provided the mangoes retain their essential characteristics as regards the quality, the keeping quality, and presentation:

- defects in shape
- skin defects due to rubbing or sunburn and suberized stains due to resin exudation (elongated trails included) not exceeding 5, 6, 7, 8 cm2 for size groups A, B, C, D, respectively
- bruising
- scattered rust-coloured lenticels
- a yellowing of green varieties due to exposure to direct sunlight, not exceeding 40 per cent of the surface of the fruit, excluding necrotic stains



Figure 3 – left: blushed fruit – right: unblushed fruit – allowed in all classes

Source: Mangoes | OECD

Provisions concerning sizing

Size is determined by the weight of the fruit, see Table 7 below.

Table 7: Provision for fresh mango sizing

To ensure uniformity in size, the following provisions must be respected: Size code	Weight in grams	Maximum permissible difference between fruit within the package in grams
A	100 – 350	75
B	351 – 550	100
C	551 – 800	125
D	> 800	150

Adapted from UNECE, OECD and Codex Mango Standard

Provisions concerning tolerances

Tolerances in respect of quality and size shall be allowed in each package for produce not satisfying the requirements of the class indicated.

Quality Tolerances

"Extra" Class

Five percent by number or weight of mangoes not satisfying the requirements of the class, but meeting those of Class I or, exceptionally, coming within the tolerances of that class – see Fig 4.



Figure 4 – very slight superficial defects – limit allowed in extra class

Source: Mangoes | OECD

Class I

Ten percent by number or weight of mangoes not satisfying the requirements of the class, but meeting those of Class II or, exceptionally, coming within the tolerances of that class-see Fig 5.



Figure 5 – slight bruising: limit allowed in class I

Source: Mangoes | OECD

Class II

Ten percent by number or weight of mangoes satisfying neither the requirements of the class nor the minimum requirements, apart from produce affected by rotting, marked bruising or any other deterioration rendering it unfit for consumption-see Fig 6.



Figure 6 – suberized stains due to resin exudation – Limit allowed in class II

Source: Mangoes | OECD

Size Tolerances

For all classes, 10% by number or weight of mangoes in each package are permitted to be outside (above or below) the group size range by 50% of the maximum permissible difference for the group. In the smallest size range, mangoes must not be less than 180 g and for those in the largest size range a maximum of 925 g applies, as follows in Table 8 below:

Table 8: Fresh mango size tolerances

Size Code	Normal Size Range	Permissible Size Range (< 10% of fruit/package exceeding the normal size range)	Max. permissible difference between fruit in each package
A	200 – 350	180 – 425	112.5
B	351 – 550	251 – 650	150
C	551 – 800	426 – 925	187.5

Adapted from UNECE, OECD and Codex Mango Standard

Provision for Fresh mango presentation

Uniformity

The contents of each package must be uniform and contain only mangoes of the same origin, variety, quality and size. The visible part of the contents of the package must be representative of the entire content- see Fig 7, 8, and 9.



Figure 7 – Uniformity in the extra class

Photo credit: Mangoes | OECD



Figure 8 – Uniformity in class I

Photo credit: Mangoes | OECD



Figure 9 – uniformity in class II

Photo credit: Mangoes | OECD

Packaging

Mangoes must be packed in such a way as to protect the produce properly. The materials used inside the package must be new, clean, and of a quality such as to avoid causing any external or internal damage to the produce- see Fig 10. The use of materials, particularly of paper or stamps bearing trade specifications, is allowed, provided the printing or labelling has been done with non-toxic ink or glue.

- Stickers individually affixed to the produce shall be such that, when removed, they neither leave visible traces of glue nor lead to skin defects. Information lasered on single fruit should not lead to flesh or skin defects.
- Packages must be free of all foreign matter.
- Clean materials should be used to protect the produce from foreign matter such as leaves, sand or soil, which could cause a negative impact on the produce and its presentation. A visible lack of cleanliness in several packages could result in the goods being rejected.

Mangoes shall be packed in each container in compliance with the Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables (CAC/RCP 44-1995), (CODEX, 2004).



Figure 10 – Consignment of fresh Apple mangoes packed in boxes

Photo credit: Gautefresh

Description of Containers

The containers shall meet the quality, hygiene, ventilation and resistance characteristics to ensure suitable handling, shipping and preserving of the mangoes. Packages (or lot for produce presented in bulk) must be free of all foreign matter and smell.



Figure 11 – Reefer container loaded with fresh mangoes ready for seafreight

Photo credit: Courtesy of Keitt

Marking or Labelling

Consumer Packages

In addition to the requirements of the Codex General Standard for the Labelling of Prepackaged Foods (CODEX STAN 1-1985), the following specific provisions apply:

Nature of Produce

- If the produce is not visible from the outside, each package shall be labelled with the name of the produce and may be labelled as to name of the variety. Non-Retail Containers
- Each package must bear the following particulars, in letters grouped on the same side, legibly and indelibly marked, and visible from the outside, or in the documents accompanying the shipment. For produce transported in bulk these particulars must appear on a document accompanying the goods.

Identification

- Name and address of exporter, packer and/or dispatcher.
  - Name and physical address (e.g. street/city/region/postal code and, if different from the country of origin, the country) or a code mark officially recognized by the national authority3 if the country applying such a system is listed in the UNECE database.
  - For inspection purposes, the “packer “is the person or firm responsible for the packaging of the produce (this does not mean the staff that carry out the work, who are responsible only to their employer). The code mark is not a trademark, but an official control system enabling the person or firm responsible for packaging to be readily identified. The dispatcher (shipper or exporter) may assume sole responsibility, in which case

identification of the “packer “as defined above is optional.

Nature of Produce

- “Mangoes” if the contents are not visible from the outside
  - The name of the produce may be replaced by a photo or a drawing of the produce
- Name of the variety
  - The name of the variety is compulsory for all classes

Origin of Produce

- Country of origin and, optionally, district where grown or national, regional or local place name
  - Marking must include the country of origin, i.e. the country in which the mangoes were grown (e.g. “Produce of Kenya“)

Commercial Identification

- Class
  - Stating the class is compulsory
- Size
  - Size code
  - Minimum and maximum weight
  - Number of fruits

Official Inspection Mark (optional)



Figure 12 – Example of marking printed on a package

Photo credit: Courtesy of Keitt

1.3.Mango Production Process

The production process for fresh mangoes, from planting to export stage, can be summarized in the process flow chart, Fig 13 below.

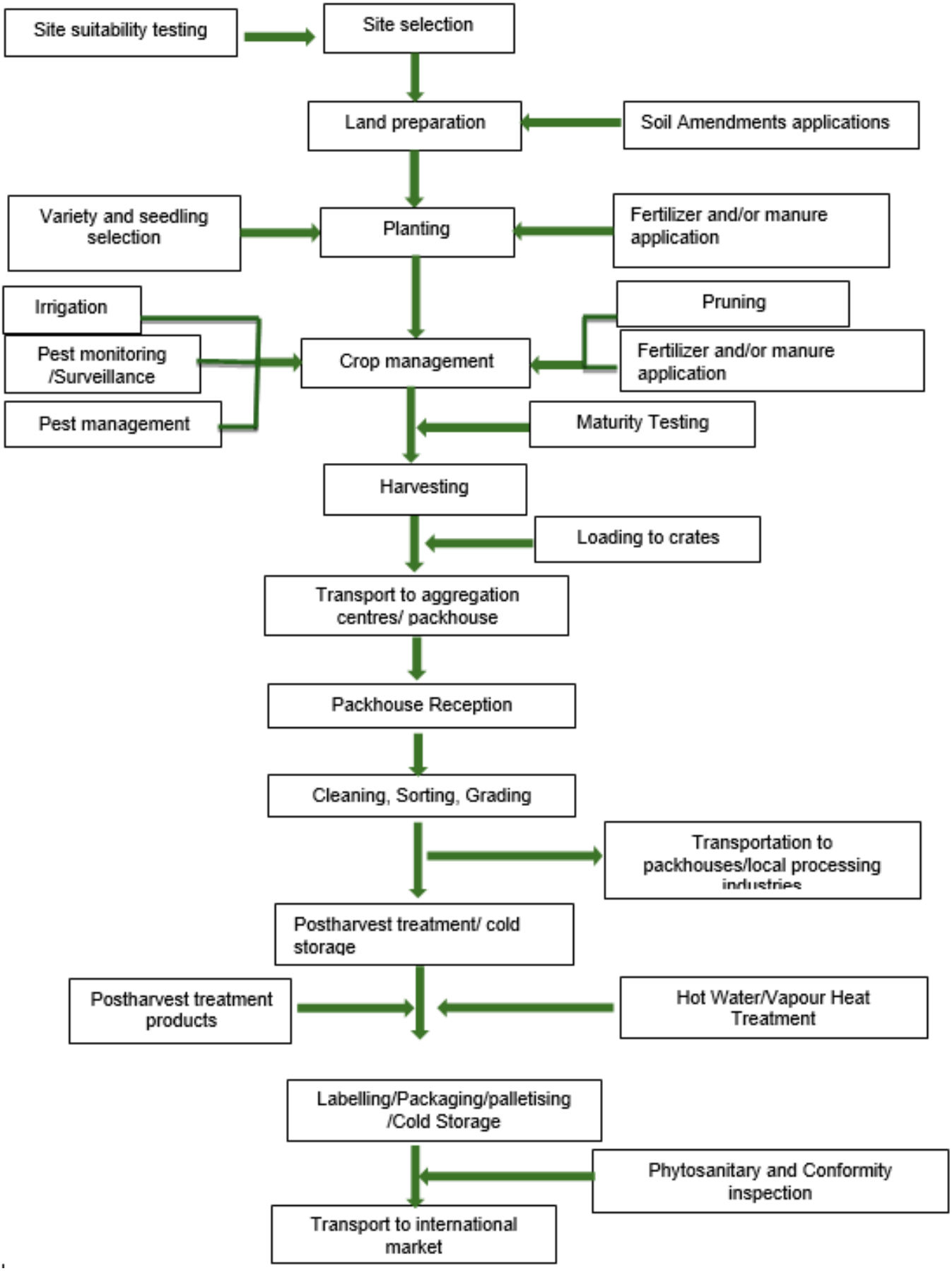


Figure 13 – Mango processing flow diagram for Kenya

2. Sanitary and Phytosanitary (SPS) Requirements for Fresh mango to the UK and other markets

2.1. National regulation and SPS requirements

In Kenya, the national SPS requisite regulations for standardization and certification are supported by several laws and regulations. The list below shows the relevant national regulations and standards relevant to mango production and marketing (domestic and international markets). The sub-sector is regulated by a total of 15 laws, including:

1. The Agricultural Produce Export Act: CAP 319
2. The Public Health Act Cap 242
3. Pest Control Products Act CAP 346
4. Imports, Exports and Essential Supplies Act: CAP 502
5. The Seeds and Plant Varieties Act: CAP 326
6. The Standards Act: CAP 496
7. The Food, Drugs and Chemical Substances Act: CAP 254
8. Agriculture Act: CAP 318
9. KEPHIS Act No. 54
10. The Public Fees Act: CAP 424
11. The Fertilizer and Animal Feedstuff act Cap 345
12. Use of Poisonous Substances Act, Cap 247
13. Agriculture and Food Authority (AFA) Act No.13 of 201
14. Crops Act 2013
15. The Horticultural Crops Regulations, 2019

The mango industry in Kenya is regulated directly by the Agriculture and Food Authority through the Horticultural Crops Directorate (HCD), KEPHIS, and the Pest Control Products Board at the national level, as well as by county governments. Other institutions that influence the development and promotion of the sector include KALRO, KEBS, PCPB, KEPROBA among others. The national government institutions are established under various statutes and have a national mandate on various regulatory aspects with a view to improving service delivery. The government has designated a competent horticultural authority structure to coordinate the horticulture industry consisting of AFA-HCD, KEPHIS, KALRO and PCPB. Other legal and regulatory frameworks influence the operations and governance of the industry. These include international standards, protocols, conventions, treaties, and agreements at the multilateral and bilateral level and codes of practice for industry associations at the local level.

The Agriculture and Food Authority (AFA), through its Horticultural Crops Directorate, provides the national export licensing framework for horticultural enterprises and is a mandatory step in any legal export pathway. Exporters must be licensed by the Horticultural Crops Directorate and present that license as part of the documentary package required for KEPHIS registration and issuance of export certificates. In practice, this means farm and company registration with the relevant county government and the AFA, company incorporation documents, and coordinated registration on KEPHIS's Integrated Export and Import Certification System (IEICS) platform before inspection and certification. National guidance documents for horticultural exporters summarise these inter-agency steps and provide the official sequence of licensing, inspection and certification that exporters must follow. (Agriculture and Food Authority – makeitkenya.go.ke).

2.1.1 Pest control products and regulations

Production-level regulatory requirements focus on plant-health management, use of pesticides and documentation of agrochemical applications. The Pest Control Products Board (PCPB) and related regulatory instruments prescribe the permitted classes of pesticides and require registration of pest control products; the national discourse has also moved toward establishing an explicit national pesticide-residue monitoring framework and clearer national MRLs. For

commercial mango growers this translates into mandatory adherence to registered product labels, avoiding off-label applications that could create export-threatening residues and keeping ledger records of pesticide applications that can be presented to auditors, certifiers or KEPHIS inspectors. Incremental national policy work on pesticide residues and the draft residue-monitoring framework emphasizes the need for systematic residue testing and reporting if exporters are to comply with EU and UK MRLs. (pcpb.go.ke), see approved pesticides for use on mangoes listed in Table 12.

2.1.2Phytosanitary requirements

The Kenya Plant Health Inspectorate Service (KEPHIS) is the officially designated National Plant Protection Organization (NPPO) of Kenya, mandated to regulate plant health, sanitary, and phytosanitary (SPS) matters for agriculture and trade. The Agriculture and Food Authority (AFA) is responsible for quality assurance of horticultural produce.

As part of its statutory functions, KEPHIS issues phytosanitary certificates as official government assurance that export consignments meet national phytosanitary requirements and applicable international standards.

This is a mandatory phytosanitary certification for all exports of fresh mangoes to all destinations, notwithstanding the United Kingdom's current classification of fresh mangoes as a low-risk product that does not require a phytosanitary certificate for import. It supports pest risk management, particularly for pests of economic and quarantine significance, ensures traceability and compliance, and aligns with international best practices in plant health protection. The continued issuance of phytosanitary certificates under this protocol therefore ensures compliance with Kenyan regulatory requirements, supports the integrity of mango exports to the UK, and safeguards Kenya's long-term market access.

A. Requirements for orchards producing fresh mangoes for export

- Fruits for export to other countries shall originate from production sites, packhouses and storage facilities approved and registered annually by KEPHIS.
- Pest monitoring shall be conducted by KEPHIS regularly in the production sites destined for export to other countries.
- Fruit fly monitoring shall be initiated three months before harvesting or when the crop for export starts to flower and this shall continue through the completion of harvest.
- The owner of the production site will be required to maintain the data and submit a copy to KEPHIS on quarterly basis.
- Farmers are advised that culled and fallen fruits are supposed to be buried, destroyed or removed away from the production sites at least twice a week.
- Registered packhouses and storage facilities shall be maintained clean free from pests, soil and plant debris safeguarded and equipped to avoid fruit contamination.
- Approved phytosanitary treatments must be inspected and certified to carry out treatments of fresh mangoes.

B. Packhouse requirements for fresh mangoes for export

- KEPHIS shall also ensure that the packhouses have a defined traceability system to approve forms for export to other countries by maintaining integrity lots.
- Normal port of exit inspections to be undertaken by KEPHIS for every consignment before.

C. Mango Exporter Requirements

i. Registration with AFA

AFA Registration: For horticultural produce, registration with the Agriculture and Food Authority (AFA) Horticultural Crops Directorate (HCD) is required. Registration is done through the IMIS system (Access AFA IMIS::Home).

How to Become a Licensed Exporter of Horticultural Produce

All applications must be submitted through the AFA IMIS Portal: imis.afa.go.ke

General Requirements

To apply for an export license, you must submit the following documents:

1. Certificate of Incorporation or Business Registration from the Registrar of Companies
2. CR12 Form or Memorandum and Articles of Association (listing company shareholders)
3. Valid Tax Compliance Certificate from KRA
4. Valid County Business Permit
5. Copies of Identity Cards for all Directors
6. If any Director is a foreign national:
   - Copy of passport
   - Valid work permit
7. KRA PIN Certificates for all Directors
8. Knowledge of KS 1758 Standard:
   - Part 1: Floriculture
   - Part 2: Fruits and Vegetables *(or any other applicable agricultural standard)*
9. Membership in relevant industry associations is encouraged

Technical Requirements

1. Farm inspection for all produce sources
2. For contracted sources, valid produce contracts between the farmer and the buyer, witnessed by:
   - The County Government (Ministry of Agriculture)
   - The HCD Regional Office

(Guidelines available on www.afa.go.ke)

1. Inspection of horticultural produce handling facilities
2. Inspection of transport facilities
3. If sourcing produce from marketing agents or suppliers, they must be registered with the Horticultural Crops Directorate

Important Notes

- Export license fee: KES 10,000 per financial year
- After obtaining your export license, you must register on the KenTrade Trade Facilitation Platform (TFP): registration.kentrade.go.ke

ii. Registration with KEPHIS

- All exporters must register through the **KEPHIS Integrated Export Import Certification System (IEICS)**.
- Key steps include:
  - Submission of a request for user access on IEICS
  - Application for approval as a plant exporter
  - Farm, packhouse, and/or facility audit and inspection by KEPHIS
- Required Documentation for registration as exporter includes;
  - Certificate of incorporation
  - Copies of directors' national identification documents
  - Company PIN/VAT registration certificate
  - Valid trade licence

Other National Requirements

- Registration with the **Kenya Revenue Authority (KRA)** for tax compliance

- Registration with the **Kenya National Chamber of Commerce and Industry (KNCCI)** for issuance of Certificates of Origin

International Requirements

- Exporters must comply with the import regulations of the destination country.
- Exporters shipping to Great Britain must register with the **UK Plant Health Export Service (PHES)**.

D. Fresh mango Export Certification

Certification is a critical component of the sanitary, phytosanitary, and quality control system for fresh mango exports. It provides official assurance that production, handling, and processing systems comply with Kenyan legislation and the importing country's phytosanitary and import requirements.

Certification under this protocol covers:

- Farms
- Packhouses/warehouses: refer to the KEPHIS and AFA packhouse inspection checklists
- Treatment facilities involved in the mango export chain

Farm Certification

All farms producing fresh mangoes intended for export to the UK and other markets must be registered and certified by **KEPHIS** and **AFA**.

Farm Audit and Inspection

- Farms must be audited and approved by KEPHIS and AFA prior to export.
- Only approved farms may supply mangoes for export.
- Each registered farm is issued with a **unique identification number** for traceability.

Good Agricultural Practices (GAP)

- Farms must comply with recognized GAP standards, including:
  - Pest management
  - Field sanitation
  - Proper use of agrochemicals
- For exporters' own farms, Integrated Pest Management (IPM) strategies must be implemented, particularly for quarantine pests such as:
  - Fruit flies
  - Mango seed weevil
- Exporters are to apply for the import permits before export

Pest Monitoring and Control

- Regular pest surveillance must be conducted using traps and field scouting.
- All control measures must be documented and verifiable during inspection.

See protocol for establishing areas of low pest populations for mango fruit flies and mango seed weevil

Traceability and Record Keeping

- Farms must maintain records on:
  - Production practices
  - Pesticide use
  - Harvest dates and quantities
- Produce must be traceable from the farm to the final export consignment.

E. Packhouse / Warehouse Certification

All packhouses or warehouses handling fresh mangoes for export must be registered, inspected, and certified by **KEPHIS** and **AFA**.

Facility Audit

- Packhouses must be audited and approved by KEPHIS and AFA before handling mangoes for export.

Hygiene and Sanitation

- Facilities must maintain high hygiene standards to prevent contamination and pest infestation.
- Cleaning and sanitation schedules must be documented and implemented.

Pest Exclusion and Control

- Effective pest-proofing measures must be in place, including:
  - Screened openings
  - Sealed doors
  - Pest monitoring systems

Sorting and Grading

- Sorting area must be well-lit and surfaces must be made of raised tables with easy-to-clean surfaces
- Mangoes must be sorted to remove damaged, diseased, or pest-infested fruit before packing.

Traceability Systems

- Packhouses must maintain records linking each consignment to the certified farm(s) of origin.

Phytosanitary Treatment Facilities – Vapour Heat Treatment (VHT)

Vapour Heat Treatment (VHT) is a phytosanitary risk-mitigation measure used to control fruit flies and other pests of quarantine and economic importance.

While VHT is **not currently required for exports to the United Kingdom**, it is a **mandatory requirement** for exports to the European Union and certain other markets.

- All VHT facilities must be registered, approved, and supervised by **KEPHIS.**
- VHT facilities must be registered through the IEICS platform.
- Approved facilities are issued with a unique identification code.
- VHT must be conducted in accordance with KEPHIS-approved protocols.

Treatment parameters include:

a. Controlled temperature and humidity
b. Specified heating duration
c. Continuous pulp temperature monitoring

- Equipment must be regularly calibrated and maintained
- Only mangoes from KEPHIS/AFA-certified farms and packhouses are eligible for VHT
- Treated and untreated fruit must be strictly segregated to prevent reinfestation

Records and Traceability

1. Facilities must maintain detailed treatment records, including:
   a. Farm and packhouse identification
   b. Batch or lot number
   c. Date and duration of treatment
   d. Temperature and humidity records
2. Records must be retained and made available to KEPHIS inspectors

Supervision and Verification

1. VHT operations are subject to routine audit and verification by KEPHIS.
2. KEPHIS may witness treatments or review electronic logs.
3. Non-compliance may result in suspension or withdrawal of approval.

Market-Specific Application

1. For EU and other markets, VHT is a prerequisite for phytosanitary certification.
2. For the UK market, VHT is not mandatory but may be applied as a national phytosanitary measure where necessary.

Where applied, VHT details may be reflected in the **"Disinfestation and/or Disinfection Treatment"** section of the phytosanitary certificate.

2.1.3 Food safety regulations

Food safety law and crop-specific regulations further set the national expectations for both fresh and processed mango. The Crops (Food Crops) Regulations and related food-safety policy instruments provide the statutory basis for sampling, testing and seizure of contaminated or unsafe food crops at collection centres, warehouses or processing plants. These regulations enable the competent authority to determine to produce pending analysis and to act when MRLs, contamination or unsanitary practices are detected. Complementary national policy work on food-safety seeks to harmonise roles across ministries, county authorities and laboratories so that processed fruit intended for export meets the safety criteria demanded by international markets. (Kenya Law Reports – Kenya Law).

Post-harvest and packhouse compliance are formalized through a combination of statutory inspections and recognized private standards. Kenya's Packhouse and processing facilities that supply export markets must operate to recognised food-safety management systems. For dried mango processors, assurance of food safety through HACCP, ISO 22000 or equivalent systems is a practical requirement because buyers in the EU and UK demand documented hazard controls, moisture-control regimes, sulphur dioxide testing (where sulphur is used), and traceability for each batch. For fresh mango, packhouses must provide adequate grading, traceability, pre-cooling and containers that enable the temperature and atmosphere conditions required by chosen logistics routes. The Kenya Bureau of Standards (KEBS) publishes national product specifications that underpin these requirements, including a national specification for fresh mango and an explicit Kenya Standard for dried mango products, and these standards serve as the technical reference points for both domestic inspections and buyer audits. (kebs.org).

Relevant Food Safety standards that are directly linked to the mango sector include:

1. KS 1559:1999 – Vocabulary in fresh fruit and vegetables
2. KS 1551-1 to 3:2001 – Code of practice for handling and distribution of fresh fruits
3. and fresh fruit products
4. KS ISO 2169:1999 – Fruits and vegetables – Physical conditions in cold stores
5. Definitions and Measurements
6. KS 220-parts 1-8:1979 (Confirmed, 1999) – Methods for the microbiological examination of foods – Part 1: General procedures and techniques
7. KS 140:1980 (Confirmed, 1999) – Methods of test for processed fruits and vegetables
8. KS CAC/RCP 8:1976 – Recommended code of practice for the processing and handling of quick-frozen foods
9. KS ISO 6661:1999 – Fresh fruit and vegetable – Arrangement of parallelepiped packages in land transport vehicles
10. KS 05-40:1990 – Labelling of pre-packaged foods (First Revision)
11. KS 1758-2: 2016 – Horticulture Industry Code of practice-Fruits and Vegetables
12. KS EAS 329:2017 – Fresh Mangoes-Specification

2.2. International SPS and other Requirements relevant to mango in Kenya

2.2.1 International Standards on Phytosanitary Measures (ISPMs) of the IPPC

The relevant IPPC ISPMs applicable in the chain define measures to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control, with minimum disruption to trade, selected ISPMs and the corresponding requirements by the fresh mango exporter include:

1. ISPM 4: Pest Free Areas) for requirements for establishing and maintaining a "pest-free area" status for a country or region. If mangoes are sourced from such an area, specific treatments may not be necessary.
2. ISPM 10: Pest Free Place of Production for requirements for establishing and maintaining a pest-free place of production area, like ISPM 4, but on a smaller scale e.g., a specific orchard or production site.
3. ISPM 12: Phytosanitary Certificates for the format and content of the official phytosanitary certificate that must accompany every consignment. The certificate confirms that the produce has been inspected and meets the export destination market /importing country's requirements.
4. ISPM 14: Systems Approach for provides guidelines for using a combination of two or more independent measures e.g., field controls + post-harvest treatment + inspection to manage pest risks effectively.
5. ISPM 23: Guidelines for Inspection for the official procedures for the visual inspection of consignments by the NPPO
6. ISPM 28: Phytosanitary Treatments for annexes with specification on approved, effective treatments for regulated pests, such as hot water treatment or vapor heat treatment for fruit flies.
7. ISPM 31: Methodologies for Sampling for guidelines on statistically sound methods for sampling a consignment to ensure a 95% confidence level of freedom from pests.
8. ISPM 46: Commodity-specific standards for phytosanitary measures to support the development of phytosanitary import requirements that are technically justified and facilitate safe trade
9. ISPM 46 Annex CS 01: International movement of fresh Mangifera indica fruit for guidance for national plant protection organizations (NPPOs) on pests associated with fresh *Mangifera indica* (mango) (Sapindales: Anacardiaceae) fruit and options for phytosanitary measures for the international movement of fresh *M. indica* fruit.

The export destination markets globally are applying sanitary and phytosanitary procedures and controls on international standards in accordance with the WTO SPS Agreement. These markets such as EU and the Middle East and UK have various sanitary and phytosanitary requirements with the aim to protect human, plant health and the environment from potential risks that may be associated with the importation of fresh mangoes into their territories/ region or countries. Kenya, through its relevant competent authorities for plant health and food safety, ensuring compliance with these requirements, through its SPS systems, certifies the implementation of these measures at production, harvesting, post-harvest certification and inspection systems. Relevant specific market requirements are listed below:

2.2.2 Codex Alimentarius Commission standards

Codex Alimentarius Commission (Codex) standards on mango. Relevant Codex standards include:

1. CODEX STAN 184-1993: This standard applies to commercial varieties of mangoes grown from *Mangifera indica* L., of the *Anacardiaceae* family, to be supplied fresh to the consumer, after preparation and packaging. Mangoes for industrial processing are excluded.
2. CODEX STAN 193-1995: Codex Standard for Contaminants and Toxins in Food and Feed gives provisions for maximum residue limits for pesticides as established by the Codex Alimentarius Commission.
3. CAC/RCP 1-1969, REV, 5 (2020): "Recommended International Code of Practice
   - General Principles of Food Hygiene" These requirements apply to all
   - WTO countries that have signed the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).
4. CAC/RCP 53-2003: Code of Hygienic Practice for Fresh Fruits and Vegetables
5. CAC/GL 21-1997: Principles for the Establishment and Application of Microbiological Criteria for Foods (implementation of quality standards, lists, recommended methods for sampling of produce; analysis and determination of pesticide residues.
6. CAC/RCP 44-1995: Code of Practice for the Packaging and Transport of Fresh Fruits and Vegetables

7. CODEX STAN 1-1985: General Standard for the Labelling of Pre-packaged Foods
8. CAC/RCP 20-1979: The Code of Ethics for International Trade in Foodstuffs

2.2.3 EU regulations and directives on food safety and plant health

1. Commission Delegated Regulation (EU) 2019/1702- The Plant Health Law – establishing the list of priority pests. including *Thaumatotibia leucotreta, Bactrocera dorsalis* and *Bactrocera zonata* as EU Quarantine pests with high impact and requires enhanced measures by EU member states. Exported fresh mango to the EU must conform to one of the following options:
    a. From a country recognized as free from Tephritidae
    b. From an area established by the NPPO as being free from Tephritidae
    c. No signs of Tephritidae have been observed at the place of production and its vicinity in official inspections carried out at least monthly during three months before harvesting
    d. Subjected to an effective systems approach or effective post harvest treatment to ensure freedom from Tephritidae
2. Regulation (EC) No 2016/2031 on protective measures against pests of plants that establishes the control of the introduction and spread of non-indigenous organisms harmful to plants or plant products.
3. Regulation (EC) No 2017/625 on official controls and other official activities to ensure compliance with food and feed law, animal health and welfare, plant health and plant protection product rules.
4. Regulation (EC) No 852/2004 on the hygiene of foodstuffs, which stipulates the widespread application of procedures based on the HACCP principles, combined with the implementation of good hygiene practices and the establishment of Good Practice Guides. This regulation covers general hygiene provisions applicable to primary production and to related operations such as transport, warehousing and handling.
5. Regulation (EC) No 178/2002 laying down procedures in matters of food safety: the traceability of food must be established at all stages of production, processing and distribution (cf. Chapter II – Section 4 – Article 18 of the Regulation).
6. Regulation (EC) No 2073/2005 – on microbiological criteria for foodstuff and describes rules for sampling and preparation of test samples.
7. Regulation (EC) 396/2005 – establishes the EC Maximum Residue Level (MRL) Harmonisation programme. It establishes the MRLs applicable to pesticide residues.
8. Commission Implementing Directive (EU) 2019/523 – amending Annexes I to V to Council Directive 2000/29/EC on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community.
9. Directive 93/43/EEC of 14 June 1993 on the hygiene of foodstuffs.
10. Directive No. 2002/63/EC referring to sampling methods for the official control of residues of plant protection products in and on products of plant origin.
11. Regulations (EC) No. 1107/2009 and No. 396/2005 governing respectively the marketing authorisation of plant protection products and the setting of Maximum Residue Limits for Pesticide Residues in the EU.
12. EU Official Control Rules (OCR). This regulation includes phytosanitary controls. The OCR replaces Regulation (EC) No 882/2004 on official controls throughout the agri-food chain. The European regulatory basis for official controls (food safety and others) is included in the OCR.
13. Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007.
14. Regulation (EU) No 543/2011 lays down detailed rules for the implementation of Council Regulation (EC) No. 1234/2007 as regards the vegetable and processed fruit and vegetable sectors. These Regulations set out rules on the classification of products, checks on conformity to marketing standards and methods of inspection. Specific articles concern producers' organizations and their recognition.
15. Regulation (EU) 2019/2072 (Plant-health / quarantine-pest regulation.
16. Commission Implementing Regulation (EU) 2020/1216 — detailed measures for fruit imports to prevent introduction of Bactrocera spp.
17. Regulation (EU) 2024/3115 of the European Parliament and of the Council amending Regulation (EU) 2016/2031 as regards multiannual survey programmes, notifications concerning the presence of regulated non-quarantine pests,

temporary derogations from import prohibitions and special import requirements and establishment of procedures for granting them, temporary import requirements for high-risk plants, plant products and other objects, the establishment of procedures for the listing of high-risk plants, the content of phytosanitary certificates and the use of plant passports, and as regards certain reporting requirements for demarcated areas and surveys of pests and amending Regulation (EU) 2017/625 as regards certain notifications of non-compliance.

18. COMMISSION IMPLEMENTING REGULATION (EU) 2024/2004 amending Implementing Regulation (EU) 2019/2072 as regards the listing of pests and rules on the introduction into, and movement within, the Union territory of plants, plant products and other objects.

2.2.4 UK Export Requirements for Fresh Mangoes

1. The Phytosanitary Conditions (Amendment) Regulations 2025Regulations amend Annexes 2, 2A, 5, 7 and 11 of Commission Implementing Regulation (EU) 2019/2072 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council as regards protective measures against pests of plants (EUR 2019/2072) (the "Phytosanitary Conditions Regulation").
2. Plant health controls for plants and plant products are managed by APHA (the Animal and Plant Health Agency) in England and Wales, and SASA (Science and Advice for Scottish Agriculture) in Scotland Depending on the country of origin, the following requirements are listed in the Guidance Exporting fruit and vegetables from Africa to Great Britain, (DEFRA and APHA, 2023).

    iii. A Phytosanitary Certificate (PC); not required for fresh mangoes

    iv. The GB importer to inform UK authorities ahead of the fruit or vegetable products arriving in GB

    v. Labelling to meet the relevant marketing standards

The Border Target Operating Model (BTOM) risk categorisations for plants, plant products, wood and wood products from the European Union (EU) and Switzerland (CH) and all other countries into (i) High Risk, (ii) Medium Risk A, (iii) Medium Risk B and (iv) Low Risk. Fresh mango is listed by DEFRA and APHA, 2023 in the guidance as not requiring a phytosanitary certificate, suggesting that the competent authority considers mango imports as "unregulated" or "low risk" under current risk assessment. However, assessment of plant health risk is usually an ongoing, and risk categorisations may change depending on the origin country, pest presence, season, and outbreak status. Currently, fresh mango exports do not require a phytosanitary certificate and no further plant health controls.

Fresh mango exports will comply with General Marketing Standards (GMS) as listed under COMMISSION IMPLEMENTING REGULATION (EU) No 543/2011 of 7 June 2011 laying down detailed rules for the application of Council Regulation (EC) No 1234/2007 in respect of the fruit and vegetables and processed fruit and vegetables sectors (see here: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/869242/marketing-standard-general-marketing-standard.pdf). The fresh mangoes must be:

i. intact

ii. sound (for example, not rotten, severely bruised or severely damaged)

iii. clean (as is practically possible)

iv. free from pests (as is practically possible)

v. free from damage caused by pests affecting the flesh (as is practically possible)

vi. free of abnormal external moisture

vii. free of foreign smell or taste

viii. sufficiently developed or ripe but not overdeveloped or overripe

2.2.5 EPPO Standards

1. EPPO Standard PM 1/002 (29) – presents and explains the EPPO A1 and A2 Lists of pests recommended for regulation as quarantine pests including Bactrocera dorsalis A1/233, Bactrocera zonata A2/302, Thaumatotibia leucotreta A2/377; Sternochetus mangiferae A1/286).
2. EPPO Standard PM 1/001 – This standard gives guidance to EPPO Member Governments on the definition in their phytosanitary regulation of requirements for phytosanitary certificates to accompany imported consignments of plants, plant products and other commodities.

3. EPPO Standard PM 3/37 — outlines phytosanitary measures for Tephritid fruit flies.

2.2.6 United Nations Economic Commission for Europe (UNECE) Standards on fresh mangoes

UNECE STANDARD FFV-45 concerning the marketing and commercial quality control of fresh mangoes exported to help facilitate international trade, encourage high-quality production, improve profitability and protect consumer interests. It defines mango produce and give guidance on quality, maturity requirements, sizing and classification and acceptable tolerances including requirements for packaging and labelling of produce (UNECE, 2023).

2.2.7 Organization for Economic Cooperation and Development (OECD) standards on mango

OECD International Standardization for fruit and vegetables; Mango provisions include mango fruit quality, maturity requirements and classification, sizing uniformity, packaging, labelling and defines tolerances. The OECD standard on mango is like the UNECE standard FFV-45.

2.2.8 ISO Standards

1. ISO 22000: Food safety management systems that integrate HACCP into ISO 9001.
2. ISO 22000 sets out what an organization needs to do to ensure the production of safe products and enhance its overall food safety performance. During implementation, one needs to refer to technical specifications such as ISO/TS 22002 Part 1: Prerequisite programmes on food safety – Food manufacturing; and ISO/TS 22002 Part 3: Prerequisite programmes on food safety – Farming.
3. ISO 9001: Quality Management System.

2.2.9 Private Voluntary Standards Requirements

Certain retailers and importers require mango producers and exporters into the UK to comply with certain private voluntary standards (PVS). These standards mainly revolve around: food safety, environmental management, sustainable production, workers' health and safety, and fair trade.

Common standards include the following:

GLOBALG.A.P. IFA is a standard that seeks to promote food safety, workers' health and safety, and environmentally responsible farming practices in the horticulture sector, mainly through Good Agricultural Practices (GAP).

GLOBALG.A.P. Risk Assessment on Social Practice (GRASP): This is a GLOBALG.A.P. add-on that can only be implemented once a producer or exporter gets certified to GLOBALG.A.P. IFA. It assesses the social practices within the farm such as workers' health and safety, and welfare.

Organic Standards: The overarching goal of organic standards is environmental conservation coupled with high standards of animal welfare, and transparency in the process to ensure client confidence on the 'organic status' of the product. Practices that enhance biodiversity, preserve soil health, and conserve natural resources are implemented.

Fairtrade Standard for Fresh Fruit: This standard seeks to ensure decent prices for farmers' products, safe working conditions for producers and traders, and environmental protection.

Rainforest Alliance standards: (a) Rainforest Alliance Sustainable Agriculture Certification seeks to improve farmer livelihoods, human rights, environmentally friendly practices, and climate resilience; whereas (b) Rainforest Alliance Regenerative Agriculture Certification is about nature-positive practices that enhance soil health and fertility, biodiversity, and climate resilience.

Other standards include LEAF Marque.

BRCGS Food Safety: Though there are other BRCGS standards on packaging, gluten-free products, ethical trade; BRCGS Food Safety standard is a common requirement imposed by UK clients for mango packhouses. The standard ensures that food manufacturers (mango packhouses) adhere to food safety requirements, thereby complying to legal requirements and ensuring safe food.

FSSC 22000: The standards borrow from ISO 22000 requirements; it is more comprehensive and is GFSI-benchmarked.

2.2.10 Traceability

To export to the UK, a producer should have a traceability system that records information on the mango fruits from input supply and growing to harvesting and transportation to the packhouse.

The following list is the minimum data that should be kept by the farmer for traceability purposes:

- Field where the mango was harvested (Farming block)
- Processor details (Company name, company logo, barcode/QR)
- Pallet number
- Supplier details/reference -user the National Horticulture Traceability System (NHTS) by HCD (see here:
- Purchase order, invoice
- Customer reference
- Quality control results

The crates with harvested mango from the mango orchard should be marked with the following information for easy identification:

- Farm/farmer name or code
- Variety name
- Planting date
- Block name/Block number/size
- Weight of fruit harvested
- Harvesting date

The following records should be kept by the orchard management

- Pest control records including name of product(s) used, date of application etc. (see record sheet)
- scouting records including dates and results (see record sheet)
- fertilizer application records including type of fertilizer, date of application, and amounts applied (see record sheet)
- irrigation water quality records that encompass the laboratory test results and sampling dates
- soil test records consisting of the laboratory test results on nutrients or pollutants
- Fruit sampling records, including sampling dates, blocks sampled, number of samples collected etc.

Traceability of batches

The traceability system should allow getting information on the mango fruits with the details of the orchard, location, field variety, harvest date and should be applicable to all stages of the mango value chain, from nursery to sale. The traceability system should provide associated quality control test results.

The following list is the minimum data that should be available to the packhouse from the orchard for traceability purpose

- Farm details (name of the farm, location)
- Field where harvested (Farming block)
- Variety name
- Harvested weight
- Pallet number
- Supplier details/reference (where applicable)
- Purchase order, invoice
- Quality control results

The products from the packhouse are to be marked with the following information for easy identification.

- Variety name
- Source of the mango/land of origin

- Weight
- Packing date
- Pallet number/ Pallet creation date
- Batch number/ batch pack date
- Country of origin
- Shipping date
- Customer reference
- Transport company

A traceability code issued by KEPHIS shall be included in the phytosanitary certificate for all post harvest treatment undertaken.

3. Description of Mango Production Processes

3.1. Nursery Establishment and Management

All commercial fruit nurseries whose fruits are destined for the export market must be registered by AFA HCD, and the seedlings must have a valid phytosanitary certificate from KEPHIS.

General considerations

Planting healthy, homogeneous, and well-formed plants is essential for a successful orchard. Factors to consider when establishing a mango seedling nursery include:

- Availability of water
- Availability of fertile, well-drained soil
- Security
- Technical know-how
- Appropriate siting (away from old orchards)

Producing grafted plants in a nursery can ensure greater consistency and cost-effectiveness. The denser the plantation, the more important it is to ensure the homogeneity of the plants, and well developed root system, rather than if the plants spend too long in containers.

The nursery production cycle should not exceed 12 to 18 months, depending on the climate of the region. Any longer and the plants would be too old and the trauma caused by transplanting and rolling the roots in the bags would prevent them from making a good recovery and hamper the trees'longevity.

To overcome this problem, plants that are grafted in the nursery should be planted in the field as quickly as possible, and containers of a suitable size (3 litres minimum) should be used, pierced with enough holes to allow the roots to come out rather than turn back inside and down to the base of the container. Finally, on the plantation, all tangled and rolled up roots are severed. The mortality rate when planting these plants is very high and the survivors develop slowly. The future of the orchard can be compromised right from the planting stage

A number of different techniques can be combined. For instance, plants can be grafted in the field, and those plants that fail or develop incorrectly can be replaced by plants grafted in the nursery.

There are various propagation techniques: sowing, grafting and layering. In practice, only grafting is used for the production of mango plants whose fruit is intended to be exported. The plant produced is made up of two parts: the rootstock (root system) and the scion (grafted part or the harvested variety).

Choosing seeds for the production of rootstocks

Rootstocks are selected to influence the health and productivity of the mango trees, the quality of the fruit, and the resistance to soil parasites. However, little research has been conducted on the matter. Consequently, each production region usually uses seeds of one or two polyembryonic mango varieties that are well-suited to the local conditions for the production of rootstocks. The benefit of using seeds derived from polyembryonic varieties is that they produce very consistent young plants, provided that plants derived from sexed embryos are eliminated (although these are rare).

- Only polyembryonic varieties (Sabre, Peach, and Dodo) should be chosen as rootstocks because they enable plants with consistent seedlings to be obtained (same genetic heritage).
- Seeds must come from identified trees, selected for their compliance with the criteria required and no symptoms of diseases or degeneration.
- Seeds must be taken from ripe fruits and should be as fresh as possible at the time of planting.
- Before planting, the hard woody endocarp should be removed to examine the seed for disease or any damage caused by the mango weevil (*Sternochetus*).
- Freshly sown seeds should be protected from high temperatures and dessication by providing shade.

Preparation of seeds for rootstock before sowing

- Harvested selected rootstock seeds just before reaching maturity.
- Do not use seeds that have stayed more than 2 weeks.
- Separate from the rest of the pulp and store temporarily on a shady, dry, flat surface before extracting the seed.
- Dehusk (to remove the hard shell), which may cause the young root to roll up during germination.
- Sow immediately after extraction (on the same day or the morning after providing the stones are kept in a humid environment).
- Remove defective seed (germination already started, signs of fungal attack or pests (*Sternochetus mangifera* = *Cryptorhynchus mangiferae*), and so on).

Germination hotbed preparation

This is essentially a sandbed made of moist fine sand meant to generate heat to trigger germination of the dehusked seed. To prepare the hotbed.

- Mix organic matter and sand.
- Place dehusked seeds on clean ground and cover lightly with the prepared organic matter and sand mix.
- Water lightly to ensure the required humidity for germination.
- Once germinated, select healthy, vibrant sprouting seeds.
- Continue watering before transplanting to the potting mix.
- Dehusked seeds can be sown directly into the potting mix.

Preparing potting mix for planting of germinated seeds

The goal is to obtain a homogeneous and filtering mix, which is able to hold enough water and nutrients.

- Mix one-third non-clay forest soil, one-third coarse sand, and one-third well-decomposed organic matter.
- Disinfect the potting mix by solar heating under transparent sheeting for 2 weeks during hot sunny periods.
- Continue watering the potting mix during solarization.
- It is important to wait between three weeks and one month before using it.
- Once solarized, fill bags with a diameter of 15cm and a depth of 20/25cm.

Transplanting seedlings from the hotbed

- Planting out should be done when the reddish leaves of the mango seedlings reach 6-8cm. The radicle will then be around 10cm long.
- Coil the roots to make planting out easier and encourage the development of secondary roots.
- Use black polyethylene bags with a thickness of 0.04mm and a volume of 3-5 litres, pierce the sides and the bottom.
- Make ditches at a depth of 0.15m and arrange the plants in parallel lines to protect them from solar radiation.
- Where polyembryonic seeds (ie several seedlings per seed) are used, always ensure that twin plants do not grow in the same bag by removing any extra plants. Plant them out separately, taking good care to divide up the cotyledons to keep their tigella and radicle intact. However, it is advisable to only use the most vigorous plants and get rid of the weaker ones. Thinned out plants can only be used when there is a lack of plants.

Sowing of germinated seed directly into the potting mix

- Sow immediately after germination.
- Lightly press the germinated seed into the potting mix and gently covered by 2-3cm of compost.
- Water the planted pots to keep them damp, without excess water, by regular watering.
- Germination requires between 6 and 30 days.
- Seeds can be sown directly in bags on-site.

Grafting

Choosing scion

The choice and condition of the Scion is extremely important. They should be taken from trees whose varietal authenticity has been verified.

- The scion must be from mature tree new shoots following a fruiting season.
- When a graft is taken, it must be “mature”, i.e. it has lost its flexibility as the stalk has become woody. The terminal bud should be bulbous, swollen and ready to open, but should not have started opening yet.
- If the terminal bud is not displaying these features, it is advisable to strip the leaves off the last 15cm of the branches. This will encourage the terminal buds to swell. They can then be removed between 8 and 15 days later.

Preparing the rootstock

At the time of grafting, the rootstocks must be at least 6mm in diameter and 30cm tall. They should be prepared two months before grafting by removing all lateral branches, so only the main stalk remains.

Grafting periods

Grafting periods depend heavily on the development of the rootstock and the vegetative development stage of the trees in the tree farm. It is not recommended to carry out grafting during very hot or very rainy seasons, or during cool seasons.

The best results are obtained during seasons which encourage the mango trees to produce a large amount of vegetative shoots.

Grafting techniques

The aim of grafting is to bring the cambiums of the graft into contact with the rootstock so that they bond together. For this to take place, it is important that:

- The meristems are and remain active throughout the period before and after the grafting
- There is sufficient contact surface between them
- The bindings used ensure close contact
- It is essential to prevent any of the tissue of both the rootstock and the graft from drying out

Various different techniques are used and they differ depending on the location. The most common approaches are:

- The splice graft
- The whip graft
- The side cleft graft
- The side veneer graft

Whichever technique is used, the following precautions must be taken:

- Whether in the nursery or on-site, grafting should use healthy grafts (completely free from bacterial canker and fungal diseases especially).
- The plant matter should be disinfected by soaking it in a mixture of insecticide, fungicide and bactericide before grafting. The grafts can also be disinfected by soaking them for 15 minutes in a bleach solution (1% active chlorine and, if possible, add a wetting agent).
- For proper disinfection, ensure that the grafts do not have any cankers because the chlorine solution cannot penetrate them.

Postgrafting care

- The bud normally begins to open between 15 and 20 days after grafting.
- To speed up growth, in the event of a side graft (side cleft or side tongue graft), the top of the rootstock should be lopped off, leaving behind a tab that is long enough to train the young graft.
- In windy conditions, the bindings should be kept on until the graft has become firm. In other cases, the bindings should be removed during the second vegetative growth stage.
- During the period between grafting and sale, the plants should be weeded, irrigated and fertilised each week with 0.5g of diluted nitrogen in 1 litre of water per pot.

Plant protection measures in nurseries

Plants in nurseries may suffer from attacks from pests and diseases. Unlike adult plants which are able to withstand attacks from certain parasites without suffering too much damage, young plants in nurseries with fewer reserves are much more sensitive-see figure 14 for a well maintained nursery. The nursery phase is a pivotal stage in the future of the plantations. Poor management can lead to the rapid spread of pathogens and pests in new orchards.

Pesticides which can be used in nurseries are the same as those used to protect orchards. Their methods for use are similar with regard to the concentrations of active matter in solutions. The application of pesticide mixtures depends on the layout of the plants in the nursery. The wettability level should be slightly denser (run-off point) for anti-mealybug fungicides or insecticides, and slightly less dense for other insecticides.



Figure 14 – Well-maintained mango nursery

Photo credit: Sarah Ndegwa, HCD, AFA.

3.2. Orchard Establishment and Management

Site Selection and Agro-Ecological Requirements

Proper site selection is critical for successful mango production, particularly for export-oriented orchards. Mango trees perform best in warm tropical to subtropical climates with temperatures ranging between 24–30°C. In Kenya, suitable mango-growing zones are mainly found in Eastern and Coastal regions, see mango suitability map Fig.14 below.



Figure 15 – Land suitability Map for mangoes growing in Kenya

Source: Kenya Soil Survey, KARLO.

Orchards should be established on deep, well-drained soils, preferably sandy loam to loam, with a soil pH of 5.5–7.5. Poorly drained or waterlogged areas should be avoided as they predispose trees to root diseases. Export orchards should be isolated from unmanaged or abandoned mango orchards to reduce pest and disease pressure – see Fig 15 for a well-established mango orchard.



Figure 16 – Organic mango orchard

Photo credit: Safiorganics

Orchard Layout and Spacing

Proper orchard layout enhances tree growth, ease of management, and phytosanitary control. Optimal spacing allows

for sufficient sunlight penetration and air circulation, which helps manage pests and diseases. Closer spacing can be done for dwarf varieties. Trees should be planted in well-aligned rows to facilitate the movement of equipment, spraying operations, and harvesting. Keitt, Kent, Alphonso, Tommy Atkins, Ngowe, and Van Dyke must be planted at the recommended spacing- see Table 9 below. Orchard blocks should be clearly demarcated and mapped to support traceability, inspection, and certification requirements.

Table 9-Recommended Agroecological and spacing for mango varieties

Mango variety	Agroecological and Spacing requirements
Keitt	**General:** 8m x 8m to 10m x 10m for adequate sunlight and air **Wet/Rich Soils:** Wider spacing like 12m x 12m or 13m x 13m for abundant growth **Dry Zones:** Closer spacing like 5m x 5m or 8m x 8m where growth is less Altitude & Climate (General Mangoes) **Altitude:** Suitable for low to mid-altitudes, avoiding frosty areas **Temperature:** Prefers 25°C–35°C, needs 6-8 hours of sun **Soil:** Well-draining, sandy loam, slightly acidic to neutral (pH 5.5–7.5)
Kent	Spacing standard – 8m x 8m to 10m x10 m for general planting Dry zones/poor soils – wider spacing 10m x 10 m or more for less vegetative growth. Wet zones/Rich soils – Wide spacing 12m x 12m due to abundant growth **Lowlands to Upper Midlands:** Mangoes generally perform well from sea level up to around 1800 meters above sea level (asl) **Coastal Areas:** Excellent for varieties that prefer warmer, humid conditions, from sea level up to 500m **Eastern Kenya (Mango Belt):** Makueni, Machakos, Kitui, Meru, and Tharaka Nithi are key areas, with altitudes often around 1000-1600m, fitting semi-arid to sub-humid climates **Central Kenya:** Areas like Thika and Embu, with altitudes from 1000-1600m, also support mango cultivation **Rift Valley:** Baringo and Kerio Valley are emerging areas due to supportive conditions
Alphonso	**Standard Spacing:** The recommended spacing for Alphonso is 8m x 8m to 10m x 10m **Dry Zone/Lower Fertility:** 5m x 5m to 8m x 8m is used where tree growth is limited **High Density:** For commercial, high-density farming, spacing can be as low as 5m x 5m, often with an average of about 96 to 150 trees per hectare **Optimal Altitude:** Alphonso grows best at altitudes between **0 to 1,600 meters above sea level (m asl)** **Temperature:** Ideal daytime temperatures range between **25°C to 35°C**, with nighttime temperatures around 20°C Rainfall: Suitable for areas with rainfall of 500- 1000 mm per year

Mango variety	Agroecological and Spacing requirements
Apple	**General:** 5m x 5m to 8m x 8m, adjusting for Vigor **Rich Soils/Heavy Rain:** Wider spacing (8m x 8m or more) to manage lush growth and ensure light penetration **Dry Zones:** Wider spacing (10m x 10m) due to less growth Altitude & Climate (Ecological Needs) **Climate:** Warm tropical to subtropical, requiring a distinct dry period (3-4 months) for flowering **Temperature:** Ideal daytime 25°C-35°C (77°F-95°F) **Sunlight:** Needs 6-8 hours of direct sun daily **Altitude:** Grows well in areas with suitable temperatures, typically lower to mid-altitudes where frost is absent (dies below -3°C/25°F)
Tommy Atkins	**Standard Spacing:** A general recommendation of **8m x 8m** is widely suggested for mango trees in Kenyan conditions **High-Density Planting:** In areas with less vegetative growth (drier zones) or where high-density planting is practiced, spacing can be reduced, such as to 5m x 5m or even 4m x 3m **Wider Spacing:** In rich soils with abundant rainfall that encourages significant growth, a wider spacing of 10m x 10m or 12m x 12m may be necessary to accommodate the larger canopy **Recommended Range:** This variety grows best in **mid-altitude areas**, typically between **800m and 1600m above sea level** **Conditions:** It performs well in regions with well-drained soils and a distinct dry period, which is essential for flowering and fruit set. Areas like Makueni, Kitui, Embu, Meru, and Machakos are suitable growing regions **Optimum Temperature:** The ideal temperature range for growth is generally between 24°C and 32°C
Ngowe	**Standard Spacing:** 8m x 8m (approximately 62–70 trees per acre) to accommodate its, or other similar, large canopy sizes **High-Density Spacing:** 5m x 5m can be used for more intensive, smaller tree management **Dry Zone Considerations:** In drier zones with less growth, 10m x 10m may be used to reduce competition for water **Ideal Altitude:** 0–800 meters above sea level (lowland) **Suitable Regions:** Coastal areas (Mombasa, Kilifi, Kwale, Lamu, Tana River) and lower Eastern regions (parts of Makueni, Machakos) **Temperature:** Thrives in warm, tropical conditions, with an optimal range of 20–35°C **Rainfall:** Requires 500–1,500 mm annually but is highly tolerant to dry conditions
Van Dyke	**Dry Zones:** 10m x 10m **Wet/Rich Soils:** 12m x 12m, or 8-10m to allow for full canopy **Reason:** Wider spacing allows for better air circulation, sunlight, and larger canopy growth, maximizing yield and reducing disease. **Altitude & Climate** **Altitude:** Thrives in medium-altitude zones, like Embu County, Kenya **Climate:** Needs tropical/subtropical conditions, full sunlight, and well-drained soils (pH 5.5-7.5).

Planting and Tree Establishment

There are several orchard planting techniques:

- Sowing and grafting in the field
- Plant production in nurseries, followed by planting and grafting in the field
- Plant production and grafting in nurseries, followed by the planting of grafted plants

Planting holes, preparation, and curing

- Planting holes **60 x 60 x 60 cm** should be prepared in advance and filled with topsoil mixed with well-decomposed organic manure
- Digging holes, 90 by 90 cm by 90cm. In dry and rocky areas
- Manure application, in 3ft-by-3ft holes put 2 debes of manure,in 2ft by 2ft. Put 1 debe of manure
- Certified grafted seedlings should be planted at the onset of rains or under irrigation to ensure good establishment. Seedlings must be planted at the same depth as in the nursery bag, with care taken to avoid damaging the graft union. Mulching around young trees is recommended to conserve moisture, suppress weeds, and improve soil organic matter.

Orchard Management

Tree shaping and Pruning

Tree shaping pruning are essential orchard management practices that influence tree structure, productivity, and fruit quality. Young mango trees should be trained to develop a strong framework by removing low or crossing branches. Pruning of mature trees should be done after harvest to control tree height, improve light penetration, and enhance air circulation within the canopy. Proper pruning reduces disease incidence and improves spray coverage. All pruned materials should be removed from the orchard and destroyed to prevent pest buildup.



Figure 17-Prunning of mango tree. *Photo by Mkulima farm*

Top-Working of mango orchard

Topworking a mango tree is a grafting technique to change its fruit variety by cutting back branches and grafting desirable new varieties onto the mature rootstock, allowing for faster development and quicker fruit production than planting new trees. The process involves cutting the tree, letting shoots (suckers) grow, and then using methods like bark or cleft grafting to attach scions (buds/shoots) of the new variety, often leaving some foliage for energy, and caring for the new growth until it forms a productive canopy.

Top working trees bear after 2 to 3 years after grafting instead of 3 to 4 years when raised from the conventional way.

The process involves cutting back major branches, leaving some foliage, and grafting budwood onto vigorous new shoots or stubs using techniques like cleft or bark grafts, sealing wounds, and managing growth to support the new variety.

Key Steps

4. Timing: Best done as the tree starts new spring growth.
5. Pruning: Saw off most branches, leaving one feeder branch for photosynthesis and to protect the trunk from sunburn.
6. Shoot development: Allow new shoots to grow from the cut stumps.
7. Grafting: Once shoots are about 15cm long, graft budwood (scion) of the desired variety onto them using methods like bark grafting or side tongue grafting.
8. Sealing & protection: Seal all cuts with grafting mastic. Paint the trunk and exposed limbs with white water-based paint to prevent sunburn
9. Manage growth: Remove unwanted shoots from the original tree, leaving only the successful grafts.
10. Remove feeder branch: Once grafts are established, remove the feeder branch



Figure 18 – Topworking in mango tree. *Photo credit: Grace Oloo HCD Homa Bay County*

Irrigation and Water Management

Although mango is relatively drought-tolerant, adequate water supply is critical during flowering, fruit set, and fruit development. In semi-arid areas of Kenya, supplemental irrigation is necessary to reduce fruit drop and improve fruit size and quality. Drip irrigation is recommended for export orchards due to its efficiency and ability to minimize disease pressure. Water sources should be clean and monitored to avoid contamination risks. Irrigation practices must be documented as part of farm records.

Weed Management

Effective weed management reduces competition for nutrients, water, and light. Weed control can be achieved through manual, mechanical, or chemical methods. Mulching is encouraged as it suppresses weeds and conserves soil moisture. Where herbicides are used, only products registered by the Pest Control Products Board (PCPB) should be applied following label instructions and safety guidelines.

Canopy and Microclimate Management

Proper canopy management improves light interception, air circulation, and fruit quality. Open canopies reduce humidity, lowering disease pressure and improving fruit coloration. Good canopy structure also enhances spray penetration, which is critical for effective pest and disease control.

Flowering and Fruit Set Management

Flowering and fruit set are influenced by nutrition, water availability, and environmental conditions. Flowering Induction: A dry spell of 3-4 months is necessary to trigger flowering. Stress management during flowering, adequate pollination, and timely irrigation improve fruit retention. Fruit thinning may be practiced where necessary to improve fruit size and uniformity.

3.3. Soil Fertility and Nutrient Management

Balanced nutrition is vital for sustained productivity and export-quality fruit. Soil analysis should guide fertilizer application programs to avoid nutrient deficiencies or excesses. Organic manure improves soil structure and microbial activity, while inorganic fertilizers supply essential nutrients at critical growth stages. Excessive nitrogen application should be avoided as it promotes vegetative growth at the expense of fruiting and increases pest and disease susceptibility.

Soil Fertility management

Fertility management in mango involves a comprehensive approach, combining soil testing, organic amendments, and specific, timely applications of macronutrients (NPK) and micronutrients to optimize fruit yield and quality. Effective techniques include using 25% organic/slow-release nitrogen, split fertilizer application, foliar sprays for micronutrients, and managing soil health through mulching and cover cropping

Key Fertility Management Techniques

- **Soil Testing and pH Adjustment:** Soil should be tested for nutrients and pH, which should ideally be 5.5 to 7.5. Lime can be used to treat acidic soils.
- **Nutrient Deficiency Correction:** Micronutrients like Zinc, Boron, and Copper are often applied via foliar spray, particularly in alkaline soils where these nutrients may be deficient. Stagger fertilizer application in the fertility management schedule (need an application calendar , see Table 11 for deficiency symptoms.
- **Soil PH Management:** Maintain soil pH between 5.5 and 7.5 (Mango prefers slightly acidic to neutral). Apply lime if too acidic or Sulphur if too alkaline.
- **Integrated Soil Fertility Management (ISFM):** Combines organic (manure/compost) and inorganic fertilizers (NPK 10-20-20 or 14-14-14) to enhance soil fertility, Table 10 below.

Table 10 – Mango Fertilizer Requirements depending on mango tree age

Age of the Plant (Years)	Fertilizer Dose/Trees/Year		
	N (g)	P (g)	K (g)
1	100	50	100
2	200	100	200
3	300	200	300
4	400	300	400
5	500	400	500
6	600	500	600
7	700	500	700
10th Onwards	1000	500	1000

Courtesy of Crop Nutrition Ltd

It is recommended to apply boron as a foliar spray just before flowering, and to apply zinc during the vegetative growth stage. Manure applications of up to 50kg is advisable for older trees (10 years onwards) and 5Kg for younger trees (1-3 year).

- Split Application Schedule:
  - **At Post-Harvest (June-July):** To support tree recovery, as recommended above.
  - **At Pre-Flowering/Fruit Set (September-October):** High potassium is critical for flower induction and retention, while nitrogen supports fruit set.
  - **During Fruit Development:** To enhance fruit size, quality, and prevent premature drop. Add calcium/boron to reduce deficiencies.
- **Organic & Slow-Release Fertilizers:** Incorporating 25% of organic or slow-release nitrogen increases Soil Organic Matter (SOM) and improves long-term nutrient availability, often improving fruit Vitamin C content and sugar-to-acid ratio.
- **Soil Amendment:** Use of manure or compost (5 kg at planting, increasing by 10 kg annually up to 50 kg for

mature trees) helps maintain soil structure.

- **Mulching:** Applying a layer of organic material (leaves, grass, crop residue) under the canopy, leaving space around the trunk, reduces moisture loss, suppresses weeds, and adds organic matter.
- **Cover Crops:** Leguminous cover crops in the orchard enhance soil fertility through biological nitrogen fixation.

Table 11 Nutrients requirements and key deficiencies

Deficiency Symptoms	Nutrient type	Nutritional role
 Adapted from https://ariesagro.com/mango/	**Nitrogen (N)**	Promotes vigorous vegetative growth. Deficiency symptoms – small leaves with general yellowing Flowering/fruiting can reduce yield and promote diseases **What to do:** Apply N-fertilizer as recommended in Table 10
 Adapted from https://ariesagro.com/mango/	**Phosphorus (P)**	Essential for root development, energy transfer, and flowering Deficiency symptoms – leaf tip necrosis and dieback on some branches **What to do:** Apply P-fertilizer as recommended in Table 10

Deficiency Symptoms	Nutrient type	Nutritional role
 Photo credit: KALRO	**Potassium (K)**	The quality nutrient. Crucial for fruit size, sweetness, colour, shelf life, and disease resistance Deficiency symptoms – white, yellow or orange chlorotic spots in older leaves distributed irregularly over both upper and older leaves Die back with tip burn with small leaves **What to do:** Apply K-fertilizer as recommended in Table 10
 Adapted from TNAU Agritech portal: http://www.agritech.tnau.ac.in/horticulture/plant_nutri/mango_magnes.html	**Calcium (Ca)**	Strengthens cell walls, reducing fruit disorders like internal breakdown or soft nose Deficiency symptoms – Abnormal growth of young leaves and growing points resembling boron deficiency severe deficiency leads to death of the bud **What to do:** Apply gypsum at 50kg/Ha

Deficiency Symptoms	Nutrient type	Nutritional role
 Adapted from TNAU Agritech portal : http://www.agritech.tnau.ac.in/horticulture/plant_nutri/mango_magnes.html	**Magnesium (Mg)**	Central part of chlorophyl. Deficiency causes interveinal chlorosis (yellowing between leaf veins) Deficiency symptoms – Reduction in growth premature defoliation yellowish brown chlorosis featured by a green wedge down the central part of the leaf bronzing starting from the edge of the leaf rounded margin between each pair of lateral veins **What to do:** Apply foliar spray with Mg
 Adapted from TNAU Agritech portal: http://www.agritech.tnau.ac.in/horticulture/plant_nutri/mango_magnes.html	**Zinc (Zn)**	The most critical micronutrient for mango. Deficiency symptoms – little leaf and rosette formation, severely impacting yield **What to do:** Apply foliar spray with Zn

Deficiency Symptoms	Nutrient type	Nutritional role
 Adapted from TNAU Agritech portal: http://www.agritech.tnau.ac.in/horticulture/plant_nutri/mango_magnes.html	**Boron(B)**	Vital for pollen tube growth, fruit set and cell development Deficiency symptoms – fruit cracking and malformation **What to do:** Apply 5-10 kg Borax / ha or foliar spray of 0.25% Borax

3.4. Key mango pests and their management

Key Mango pests

Oriental fruit fly *Bactrocera invadens* now *Bactrocera dorsalis,* Mango seed weevil (*Sternochetus mangiferae*) and Black Twig Borer (BTB) *Xylosandrus compactus, scale insects* and diseases such as the anthracnose, stem end rot, powdery mildew re sme of the key pests of mangoes in Kenya. In early 2010, Kenya imposed a self-ban on fresh mango experts tot eh EU. This self-ban was a corrective measure, to enable Kenya to mitigate the quarantine pests, and avoid EU ban due to the high-risk pest interceptions. Other pests intercepted included *Bactrocera dorsalis*, which were intercepted on fresh mangoes to the UK in 2014 (Europhyt, 2014). The photo guides showing detailed signs and symptoms can be found in Annex 61-6.2.

Mango Pest and Disease Scouting

Scouting for Mango seed Weevil (MSW) in the orchard

A quarantine pest in many export markets, the larvae develop inside the mango seed; external symptoms are often minimal. It is essential that a standardized procedure for early detection, monitoring, and documentation of Mango Seed Weevil (*Sternochetus mangiferae*) infestation in mango fields, supporting pest management decisions and compliance with quarantine and export requirements. This approach can be used for mango orchards, out-grower farms, and inspection teams involved in mango production for local and export markets and can used by farm manager Field scout/ extension officer, and quality compliance officer. See the photo guide for fruit fly Annex.

Scouting Frequency & Timing

- Begin scouting **from flowering stage** and continue until harvest, thereafter continue throughout the year for monitoring purposes.
- **Frequency:**
  - Low risk areas: Once every **14 days**
  - High risk / export farms: **Weekly**
- Additional scouting after heavy fruit drop or during warm, humid periods.

Tools & Materials Required

- Field notebook / scouting record sheets

- Permanent marker
- Knife or secateurs (cleaned and disinfected)
- Sample bags (well labelled)
- GPS / farm map (if available)
- PPE: gloves, boots

Field Scouting Procedure

- Divide orchard into **blocks** (by variety, age, or location).
- Each block must be scouted separately.
- Randomly select **10–20 trees per block** (minimum 5% of trees).
- Include border trees and interior trees.
- Randomly select 30% of the number of trees in the orchard.
- Begin scouting **8 weeks after fruit set** and continue **every 2 weeks** until early ripening.
- If the orchard has **fewer than 5 fruiting trees**, sample **all trees**.
- From each tree, collect **at least 8 fruits** from **different canopy quadrants**

Egg Detection on Fruits

- Inspect fruit surfaces for **small, dark, healed egg-laying marks**.
- **Initiate control measures immediately** if eggs are detected

Fruit Sampling for Weevil Detection

- Sample fruits at **>65 days after flowering up to harvest (≈120 days)**
  OR fruits **≥70 mm in length** (stalk to apex).
- Include **fallen fruits** of appropriate size and maturity.
- Externally inspect fruit peel for **other pests** (mealybugs, scales, fruit fly damage)

Internal Fruit Inspection

- Cut fruits **longitudinally through the seed** using a clean knife or slicer.
- Inspect the **seed, cotyledons, stone, and flesh** for:
  - Internal rot on the stone surface
  - Holes in the stone
  - Black or rotten cotyledon mass
  - Adult exit holes on fruit skin
  - Secondary infection entry points

Identification of MSW

- **Adults:** Small, stout beetles with long snout; black, greyish, or reddish; legs folded tightly when disturbed.
- **Larvae:** Legless, whitish grubs burrowed inside seed/cotyledons

Specimen Handling

- Preserve suspected MSW specimens in **70% alcohol**.
- Label vials with **collection site, date, and collector's name**.
- Submit specimens for **official identification**.

Infestation Status:

- 0 = No infestation
- 1 = Suspected
- 2 = Confirmed

Action Thresholds

- **Any confirmed MSW detection** = Immediate action required
- Notify farm management and compliance officer
- Isolate affected block
- Intensify scouting to **every 3–5 days**

Immediate Control & Preventive Actions (Non-Chemical)

- Collect and destroy fallen fruits (deep burial or approved disposal)
- Maintain orchard sanitation
- Avoid movement of fruits from affected blocks
- Prune and manage canopy to reduce hiding sites

(Chemical control only as per PCPB-approved products and under professional guidance) see Mango seed weevil pest management decision guide

Data recording for the MSW in the orchard

Scouting Indicators & Rating

Indicator	Observation
Oviposition marks	Present / Absent
Fallen fruits	Low / Medium / High
Larvae in seed	Yes / No
Adult weevils seen	Yes / No

Record Keeping

Maintain records for **minimum 2–3 years**:

- Scouting dates
- Scout name
- Blocks inspected
- Findings and infestation status
- Corrective actions taken

Reporting

- Weekly scouting summary submitted to Farm Manager
- Immediate reporting of suspected or confirmed MSW to Quality/Compliance team
- Records must be available for audits (GLOBALG.A.P., KEPHIS, importing authorities) **Training**
- All scouts must receive annual training on:
  - MSW identification
  - Sampling methods
  - Hygiene and biosecurity

Review

This procedure shall be reviewed **annually** or when new regulatory or pest information becomes available.

Scouting for Fruit Fly (Bactrocera spp. and Ceratitis spp.)

Bactrocera dorsalis (Oriental fruit fly) and *Ceratitis cosyra* (Mango fruit fly) is a quarantine pest for most export markets. Its larvae develop inside fruit pulp, causing internal breakdown and rejection at export inspections. It is essential that a standardized procedure for early detection, monitoring, and documentation of **Fruit Fly (Bactrocera spp. and Ceratitis spp.)** infestation in mango fields, supporting timely pest management decisions and compliance with quarantine and export market requirements. This scouting guide can be used in mango orchards and Out-grower farms by farmers, field scouts, extension officers, quality/compliance officers and inspection teams involved in mango production for local and export markets.

Scouting Frequency & Timing

Monitoring for fruit fly should be throughout the growing season.

Mass trapping should for general monitoring of the fruit fly.

- **Begin scouting:** At fruit set
- **Continue until:** Final harvest
- **Frequency:**
  - Low risk / domestic farms: Every 14 days
  - High-risk / export farms: Weekly
- **Additional scouting required:**
  - During warm, humid periods
  - After rainfall
  - When trap catches increase
  - When premature fruit drop is observed

Tools & Materials Required

- Field notebook / scouting record sheets
- Permanent marker
- Clean knife or secateurs (disinfected between samples)
- Sample bags (clearly labelled)

Approved lures (methyl eugenol, protein bait, trimedlure – as applicable)

- GPS / farm map (if available)
- PPE: gloves, boots

Field Scouting Procedure



Figure 19 – Scouting for fruit fly

Orchard Selection

- Divide orchard into blocks based on:
  - Variety
  - Tree age
  - Location
- Scout each block separately.

Tree Selection

- Randomly select **10–20 trees per block** (minimum 5% of trees).
- Include:
  - Border trees
  - Interior trees
  - Trees near water sources or hedges

Visual Inspection (On Tree)

Inspect:

- Developing and mature fruits
- Fruits with soft spots or discoloration
- Fallen fruits under the canopy

Look for:

- Small puncture marks (oviposition stings)
- Sap oozing from fruit skin
- Dark, sunken spots
- Premature fruit drop
- Soft or fermenting areas on fruit

Fallen Fruit Examination

- Collect **5–10 fallen fruits per block**
- Cut fruit open and inspect pulp for:
  - Creamy-white maggots (larvae)
  - Brown, soft, or rotten flesh
  - Fermented smell

Trap Monitoring (Mandatory for Export Farms)



Figure 20 – Fruit fly Trap

Photo Credit: ellen Heya, KEPHIS

- Install traps at a density of:
  - **1 trap per 1–2 hectares** (or as per export protocol)
- Hang traps:
  - Mid-canopy height
  - Shaded area
- Inspect traps **weekly**:
  - Count and record number of fruit flies
  - Identify species where possible
- Replace lures and killing agents as per manufacturer instructions.

Sampling (If Suspected)

- Place infested fruits or larvae in labelled sample bags
- Labels must include:
  - Farm name
  - Block/plot number
  - Date
  - Scout name
- Submit samples to:
  - Authorized laboratory or
  - KEPHIS (if required)

Fruit Fly Field Scouting – Summary Guide

Orchard Sampling

- Randomly select 30% of the number of trees in the orchard
- Begin scouting **6–8 weeks after fruit set, then throughout the year for monitoring.**
- Continue every **7–14 days** until harvest
- If fewer than 5 fruiting trees exist, inspect all trees
- From each tree, inspect fruits from all canopy quadrants

Egg / Oviposition Detection

- Inspect fruit surface for:
  - Pin-prick marks
  - Sap beads
  - Discolored puncture sites
- Immediate action required if oviposition is observed.

Fruit Sampling for Larvae Detection

- Sample fruits:
  - From mid-development to maturity
  - Including fallen fruits of marketable size
- Externally inspect fruit for:
  - Fruit fly damage
  - Other pests (mealybugs, scales)

Internal Fruit Inspection

- Cut fruit open longitudinally
- Inspect pulp for:
  - Maggots
  - Brown tunnels
  - Soft rot
  - Secondary infections

Identification of Fruit Fly

- **Adults:**
  - Medium-sized flies
  - Yellow-brown body
  - Clear wings with dark markings
- **Larvae:**
  - Creamy-white, legless maggots
  - Found inside fruit pulp

Specimen Handling

- Preserve adult flies or larvae in **70% alcohol**
- Label specimens clearly with:
  - Location
  - Date
  - Collector's name
- Submit for official identification if required

Scouting Indicators & Rating

Indicator	Observation
Oviposition marks	Present / Absent
Trap catches	Low / Medium / High
Larvae in fruit	Yes / No
Premature fruit drop	Low / Medium / High

Infestation Status:

- 0 = No infestation
- 1 = Suspected
- 2 = Confirmed

Action Thresholds

- Any confirmed larva in fruit = Immediate action required
- Trap catches above threshold (as per export protocol) = Action required
- Actions include:
  - Notify farm management and compliance officer
  - Isolate affected block
  - Increase scouting to every **3–5 days**

Immediate Control & Preventive Actions (Non-Chemical)

- Collect and destroy fallen fruits (deep burial or approved disposal)
- Maintain strict orchard sanitation
- Use baiting and mass trapping
- Avoid movement of fruits from affected blocks
- Prune and manage canopy to reduce pest habitat

See the pest management decision guide for Fruitfly

Record Keeping

Maintain records for **minimum 2–3 years**:

- Scouting dates
- Scout name
- Blocks inspected
- Trap counts
- Findings and infestation status
- Corrective actions taken

Reporting

- Weekly scouting and trap monitoring reports submitted to Farm Manager
- Immediate reporting of suspected or confirmed fruit fly infestation to:
  - Quality / Compliance Officer
- Records must be available for:
  - GLOBALG.A.P.
  - KEPHIS
  - Importing authority audits

Training

- All scouts must receive **annual training** on:
  - Fruit fly identification
  - Trap use and interpretation
  - Sampling methods
  - Hygiene and biosecurity

This procedure shall be reviewed annually or when new regulatory or pest information becomes available.

Pest management

Management of these pests depends on the production system. Organic mango farmers, cultural pest management options, and biologicals and biopesticides. Use of pest control products must comply with the PCPB regulations on approved pesticides for use on mango and the approved MRL levels. To comply with MRLs requirements and reduce impact on the environment and ecosystem services, safe use of pesticides is highly recommended. Approved pest control products can be found on (pcpb.go.ke) and see Table 5 below for approved pesticides for mangoes.

The Pest Management Decision Guides (PMDGs) found on table 6 below recommends integrated pest management options for key mango pests.

Protocol on Establishing areas of Areas of Low Pest Populations (ALPP) for the fruit fly

The following requirements must be adhered to

1. **Baseline Survey**
   - A feasibility survey shall be conducted in the proposed PFA and ALPP areas to determine:
   - Presence or absence of the target fruit fly species
   - Availability of host plants

- Prevailing environmental and climatic conditions
- Survey results shall guide suitability for establishment.

2. **Delimitation of ALPP**
   - Clearly demarcate proposed areas using recognizable boundaries and GPS coordinates.
   - Identify core areas, buffer zones, entry points, and natural barriers.
   - Divide areas into grid systems for trapping and management.
   - Collect and document climatic data (rainfall, temperature, humidity, wind).
   - Map and geo-reference key risk factors including host availability, pest history, movement of fruits, and proximity to infested areas.
3. **Training**
   - Growers are trained by KEPHIS and county governments on establishing and maintaining ALPP for fruit flies, fruit fly identification and monitoring an record keeping
4. **Management of Fruit Flies under ALPP**

Trapping Networks

- Trap layout based on pest risk assessment (ISPM No. 11).
- Uniform grids in compact host areas; irregular arrays in scattered host areas.
- Monitoring shall be conducted bi-weekly throughout the mango growing seasons using pheromone traps.
- Trap catches shall be recorded and Flies per Trap per Day (FTD) calculated.
- Monitoring data shall be used to assess pest population trends before, during, and after control interventions.
- Continuous monitoring shall be maintained after approval to ensure sustained pest freedom

5. **Approval of the ALPP by KEPHIS**
   - If scouting data indicates 1 FTD per week, KEPHIS will approve and officially declare the area ALPP, and declare the status
   - Develop a maintenance and monitoring program for ALPP for fruit fly
   - Undertaking continuous surveillance by KEPHIS
   - ALPP shall be suspended if trap catches exceed 7 fruit flies per trap per week.
   - The detection site and emergency response actions shall be reported to KEPHIS.
   - KEPHIS shall communicate the suspension to importing countries through NPPO channels.
   - Reinstatement may occur after a period equivalent to three pest generations (approximately three months) with no detections
   - Reinstatement shall be subject to approval by the NPPO and acceptance by importing countries

Protocol on Scouting, Trapping and Management of Mango Seed Weevil

A sticky band is used to trap mango seed weevils (*Sternochetus mangiferae*) on a mango tree trunk. The band is placed just below the main branches at the point/junction where they fork, see fig 2 and 22 below. The weevils are trapped, preventing them from reaching the developing fruits as they crawl up to lay eggs. The sticky bands are useful in monitoring and control method for the mango seed weevil.

How to make and use a sticky band

- Use the bands throughout the mango growing period
- Placement:
  - Obtain a roll of yellow sticky trap
  - Roll the trap round to wrap the upper part of the trunk, just below where branches start to fork. This makes a band strip of 12-18 inches wide
  - Secure the band tightly in place. No gaps or space should be left between the bark and the band











Banding: Wrapping the tape around the trunk and the application of adhesive material. *(Source: Fruit mentorhttps://fruitmentor.com/category/pests-disease- and UW Madison University*



Sticky band on a mango tree. *(Source: rhs.co.uk)*



Band removal *(Source; https://fruitmentor.com/category/pests-disease*

Figure 21-Yellow sticky banding procedure

- Trees with rough bark it's advisable to fill in gaps using cotton balls or extra tape prevent the weevils from crawling underneath
- Use a scapel/sharp knife to cut out the loose end of the band from the roll

Alternatively, obtain a roll of plastic film (like cling wrap, duct tape)

- Wrap the trunk tightly with the plastic film and apply the sticky adhesive on it (not on the bark)
- Sticky adhesive tape include the tree Tanglefoot, Tangle-Trap, or horticultural glue
- Use disposable gloves and knife to apply the adhesive to the wrapping material
- Prune the "skirt" of the tree to ensure no branches touch the ground and shoots arising from the base that might act alternative route or bridges for the weevil to crawl up the tree

Other sticky band

- Wrap duct tape/cling film on a tree trunk

- Apply petroleum jelly or grease on the wrap
- Under the jelly leave at least two inches of uncoated band as it can melt and flow downward.

Caution. Observe care when using petroleum jelly which can melt and injure the trees especially in hot climate

- Replacement.
  - The band should be checked and replaced weekly or when covered with weevil/insects dirt, or debris
  - Slightly brush off the material stuck on the band to expose a fresh surface, or a new layer of glue can be added when necessary
  - Remove the band at the end of the season to avoid tree growth restriction, translocation process or causing rot

Approved Pesticides for use in mango in Kenya

In Kenya, diseases of economic importance in mango production include anthracnose, powdery mildew, stem-end rot, mango scab, mango black band disease, leaf rust and leaf spots. Insect and mite pests include fruit flies, thrips, mealybugs, red spider mites, mango seed weevil, mango gall midges and black twig borer.

There are some pesticides, both conventional and bio-pesticides approved for controlling some of the diseases and pests. However, there are still no products approved for some of the pests and diseases. The following Table 12 highlights the approved pesticides for use on mangos.

Table 12 – Approved pesticides for field pest and post-harvest management in the mango sector

No:	Trade name	Active substance and concentration	Formulation (Code)	Type and Mode of Action	Area of use	Target Pest	Application rate	PHI	Pre-Entry Interval	Acceptable MRL	
										EU	UK
Conventional Pesticides											
1.	BAYLETON WP 25	Triadimefon 250g/Kg	Wettable powder	Systemic fungicide with preventive, curative, and eradicant action	Field	Powdery mildew	40g of Bayleton 25 WP for every 20 litres of water	28 days	6 Hours	0.01 mg/kg	0.01 mg/kg

No:	Trade name	Active substance and concentration	Formulation (Code)	Type and Mode of Action	Area of use	Target Pest	Application rate	PHI	Pre-Entry Interval	Acceptable MRL	
										EU	UK
2.	BIODISTINCTION EXTRA 700 SC	Copper Oxychloride 700 g/L	Suspension concentrate	Contact fungicide	Field	Powdery mildew, Leaf spot & Anthracnose	1.5L/ha (30ml/20L of water)	3 days	12 Hours	20.0 mg/kg	20.0 mg/kg
3.	CLOSER 240SC	Sulfoxaflor 240g/L	Suspension concentrate	Systemic insecticide	Field	Scales.	30-40 mL of Closer 240SC per 100 L of water	14 days	Until spray dries	0.01 mg/kg	0.01 mg/kg
4.	FASTANO 500 SC	Fludioxonil 500g/L	Suspension Concentrate	Post-harvest contact fungicide	Post-harvest	Anthracnose and Stem-end rot	0.6ml/1L of water. For dipping of harvested fruits	5 days	1 Hours	2 mg/kg	7.0 mg/kg
5.	GRAMOXONE 20	Paraquat Dichloride, 200g/L AS	Aqueous solution	Non-selective contact herbicide	Field	Grass and broad-leaved weeds	1.5L/ha (100ml/20L of water)		12 Hours	0.02 mg/kg	0.02 mg/kg
6.	MANGOCOPP 230 EC	Copper Abietate 230 g/L	Emulsifiable Concentrate	Contact and Protectant Fungicide with Multi-site mode of action		Powdery mildew and Anthracnose	1.0 L/ha in 1000L of water/ ha (20ml/20L of water)		12 Hours	0.3 mg/kg	20.0 mg/kg
7.	NATIVO SC 300	Trifloxystrobin 100 g/L + Tebuconazole 200g/L	Suspension concentrate	Broad-spectrum fungicide with both protective (contact) and curative (systemic) action	Field	Powdery mildew and Anthracnose	1.5L/ha (30ml/20L of water)	3 days	12 Hours	Teb: 0.1mg/kg Trif: 0.01mg/kg	Teb: 0.1mg/kg Trif: 0.01mg/kg
8.	NIMROD 25 EC	Bupirimate 250g/L	Emulsifiable Concentrate	Systemic fungicide with protective and curative action	Field	Powdery mildew	2.5-3.0L/ha (50-60ml/20L of water)	2 days	6 Hours	0.05 mg/kg	0.05 mg/kg
9.	SUCCESS BAIT	Spinosad 0.24 g/L	Concentrated Bait (CB) formulation (ready-to-use)	By Contact and ingestion	Field	Fruit flies	0.8L/ha diluted in 9 litres of water for spot spraying on 6 mango trees	3 days	8 Hours	0.02 mg/kg	0.02 mg/kg
11.	ALION 500 SC	Indaziflam 500 g/L	Suspension Concentrate	Systemic, pre-emergent Herbicide	Field	Broadleaf and annual grass weeds	100ml/ha (10ml/20L of water)	21 days	12 Hours	0.01 US EPA	–

No:	Trade name	Active substance and concentration	Formulation (Code)	Type and Mode of Action	Area of use	Target Pest	Application rate	PHI
12.	TOKEN 325 SC	Azoxystrobin 200g/L + Difenoconazole 125g/L	Suspension Concentrate	Systemic, broad-spectrum fungicide	Field	Powdery mildew, Anthracnose and Leaf rust	0.5L/ha (10ml/20L of water)	7 days
13.	ABSOLUTE STAR 400 SC	Azoxystrobin 250 g/L + Difenoconazole 150 g/L	Suspension Concentrate	Systemic, broad-spectrum fungicide	Field	Powdery mildew, Anthracnose and Cercospora Leaf spot	0.2 L/ha (4 ml/ 20 L of water)	7 days
14.	COVALEND 45% WG	Azoxystrobin 100 g/Kg + Tebuconazole 350 g/Kg	Wettable Powder	Systemic, broad-spectrum fungicide	Field	Powdery mildew and Anthracnose	0.3L/ha (6ml/20L of water)	7 days
15.	MANGORECT 500 SC	Azoxystrobin 200g/L + Tebuconazole 300g/L	Suspension Concentrate	Systemic, broad-spectrum fungicide	Field	Powdery mildew and Anthracnose	0.3L/ha (6ml/20L of water).	7 days
Bio-pesticides								
1.	BACTROLURE 98.9% LIQUID	Methyl Eugenol 98.9%	Liquid para pheromone formulation.	Pheromone for use with Oshothion 50 EC (PCPB (CR) 0482 in Male annihilation technique (MAT)	Field	Male Fruit flies (Bactrocera invadens)	4 lures/acre for monitoring fruit fly population. 10 lures/acre for mass trapping to control fruit fly population	
2.	BIO-CHANCE 150 SL	Naringin 150g/L	Soluble Concentrate	Inhibits spore germination and mycelia growth	Field	Powdery mildew, Leaf spot & Anthracnose.	1ml per 1litre water	
3.	CERA TRAP Liquid	Hydrolysed Protein 55g/L	Soluble Concentrate (SL) or soluble liquid	Liquid food-based attractant/lure	Field	A trap for control and monitoring of Fruit fly.	600 mL per trap, and 60 to 120 traps per hectare	
4.	Eco-Bb	Beauveria bassiana Strain R444 2.0×108 cfu/g	Wettable Powder	Contact and ingestion.	Field	False codling moth (FCM) and Fruit fly.	1 g/L of water	
5.	FRUIT FLY MANIA	Yeast extract hydrolysate 5%	Liquid Attractant	Attractant and drowns the insect.	Field	Fruit flies.	10 traps/ha	

Source : PCPB (https://www.pcpb.go.ke/). Refer to the site for the updated list.

Table 13: Pest Management Decision Guide

Pre-Entry Interval	Acceptable MRL	
	EU	UK
8 Hours	4mg/kg, Azo. 0.1mg/kg Dif.	4mg/kg, Azo. 0.1mg/kg Dif.
8 Hours	4mg/kg, Azo. 0.1mg/kg Dif.	4mg/kg, Azo. 0.1mg/kg Dif
12 Hours	4mg/kg, Azo. 0.1mg/kg Teb.	4mg/kg, Azo. 0.1mg/kg Teb.
12 Hours	4mg/kg, Azo. 0.1mg/kg Teb.	4mg/kg, Azo. 0.1mg/kg Teb.
8 Hours		
4-12 Hours		

Mango Seed Weevil (*Sternochetus mangifera*)



Adult Mango seed weevil; Legs pressed against the body and snout fitted in ventral groove when disturbed
(Source: CABI and Ngugi, CN KALRO)





An egg-laying mark of mango seed weevil *(Source: A. M. Varela, ICIPE)*



Entry point on the seed stone.
(Source: Ngugi CN, KALRO)



Damage on the seed (tunneling and frass) and grub *(Source: Ngugi CN, 2026, KALRO HRI)*

Prevention

- Weekly field visit to check for:
- adults (black, greyish, reddish, or yellowish, 7.5-9.5 mm long with a long 'nose', under loose barks, around the tree base, at fork of branches or the trunk, in inflorescence, or in leaf litter.
- Immature/small fruits (marble sized fruit): Small crescent-shaped egg-laying marks (0.3 mm)
- Cut open the Fruits: larvae (legless white grubs with dark heads), pupae or adults inside, internal feeding/frass and rotting of seeds, obvious exit holes on stones
- Fruits: amber coloured secretion, abnormal shape, internal feeding, malformed skin, Premature fruit drop
- New leaves/flushes: feeding damage
- Use direct control measures once the pest is observed

Monitoring

- Avoid establishing mango on fields with a previous history of the weevil
- Source mango seedlings from reliable/certified nurseries
- Enforce strict quarantine measures for importation of plant material
- Use clean planting material to limit introduction of the weevil into the orchard
- Orchard sanitation; collect and destroy fallen fruits and mango (solarisation in black polythene bags 3 days in the sun/and in an augmentorium
- Destroy the adult weevils (during their diapause) in bark crevices before mango flowering
- Bagging of young fruits (chicken egg size)
- Avoid bringing mango seeds and fruits from infested areas to non-infested areas (nursery, orchards)
- Inter cropping with non-host plants like citrus and papaya

Non Chemical Control

- Pick and destroy adults
- Brush off the junctions of branches with a broom and destroy adults
- Trap adults at the beginning of flowering using sticky bands at the
- upper end (below the forked branches) of the
- tree trunks
- Change the bands weekly until the fruits mature
- Collect and destroy infested fruits

Chemical Control

- The weevil life cycle is mostly spent hiding in crevices and inside the fruit making it inaccessible to chemical sprays
- Currently there is no registered pest control product for the Mango seed weevil in Kenya

UK International Development

Black Twig Borer / Shot Hole Borer (*Xylosandrus compactus*)



Adult Black Twig Borer. Small shiny dark brown or black beetle *(Source: https://www.inaturalist.org/observations/63798073)*



Whitish fungal powder at point of entry. *(Source : https://nwdistrict.ifas.ufl.edu/hort/tag/black-twig-borer/)*



Internal tissue damage; Tunnels and frass *(Source: https://nwdistrict.ifas.ufl.edu/hort/tag/black-twig-borer/)*

Prevention

Monitor for pest presence /population using 75% ethanol-baited traps

Scout for signs of attack

- Pin-sized entry holes on the underside of the branch
- Yellowing of the leaves on a branch
- Whitish spongy powder (fungal growth) at the hole/point of attack
- Test for weakness by bending the suspected infested twig, which breaks at the pest's entry point
- Blackening of the stem and leaves from the entry hole to the branch tip
- Wilting of twigs and branches
- Tunneling /galleries through the young branches

Monitoring

Field sanitation

- Pruning symptomatic plants
- Proper disposal of infested materials-burning/ shredding
- Maintain tree health (adequate watering and fertilization/manuring

Non Chemical Control

- Trapping-Ethanol /water traps (15 traps per ha); Add 70% alcohol in a small plastic bottle with holes (scent lure). Suspend it inside a larger bottle containing water (drowns the attracted borer). Hang the trap on the branches

Chemical Control

- Currently, there is no registered pest control product for Black Twig Weevil in Kenya
- Chemical controls are usually difficult since the pest life stages are mostly inside the host plant; destruction and blockage of the plant transport system; the beetles do not eat the plant tissue directly

Mango Gall Midges (*Procontarinia mangiferae [Felt]*)



Adult Black Twig Borer. Small shiny dark brown or black beetle *(Source: https://www.inaturalist.org/observations/63798073)*



Whitish fungal powder at point of entry. *(Source : https://nwdistrict.ifas.ufl.edu/hort/tag/black-twig-borer/)*



Internal tissue damage; Tunnels and frass *(Source: https://nwdistrict.ifas.ufl.edu/hort/tag/black-twig-borer/)*

Prevention

Weekly field visit to look for;

- Pest damage (small red spots (galls) on young leaves/buds)
- Larvae emerging from bagged shoot tips and small exit holes from galls
- Premature fall of heavily galled leaves
- Use Yellow/clear sticky traps to catch and monitor adult midges population
- Take action when 10 galls are observed on a leaf

Monitoring

- Source planting materials from reliable/certified nurseries
- Collect and destroy fallen leaves
- Cultivate the area under the tree canopy
- Irrigate to suffocate the pupa in soil
- Prune damaged branches and after harvest (burn the materials)
- Use plastic mulch around the plant base to prevent the emergence of adult and dropping of larvae into the soil for pupation
- Field sanitation; raking and burning the fallen leaves; weeding to remove alternate hosts

Non Chemical Control

- Mass trapping of adult using the yellow sticky traps
- Collect and dispose of infested leaves (burn or place in black polythene for solarisation for 3days)

Chemical Control

Currently, there is no registered pest control product for Mango gall midges in Kenya

UK International Development

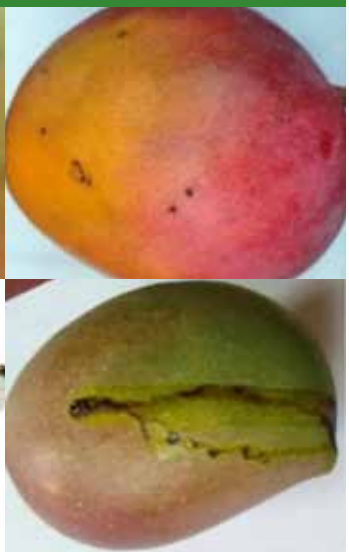
Mango fruit fly (*Bactrocera dorsalis, Ceratitis capitata, and Ceratitis cosyra*)



Mango pulp damage by larvae
(Source: Ngugi CN, 2026 KALRO)



Bactrocera dorsalis and Ceratitis cosyra
(Source: ICIPE)



Puncture for egg laying and Sap exudation from the point
(Source: Ngugi CN, 2026 KALLRO)

Prevention

Monitor using protein baits or male lures for numbers and abundance of fruit fly

Check for;.

- Adult fly- Small (1cm), colorful (yellow/black) fly resembling house flies
- pest damage; black soft/sting marks on mature fruits; sap oozing (crying fruit) from puncture mark
- Collect and cut open suspected fruits from trees and the ground; changes in colour (dark colour due to oxidation); and pulp consistency, presence of larvae
- Take action when 5-10 adult flies per catch per week/ 4-10 punctured fruits/ 5- 15% orchard infestation

Monitoring

- Maintain a hedge around the farm to conserve natural enemies and predators to reduce the population of fruit flies
- Frequent weeding to destroy and remove alternate host for fruit flies
- Prune the mango tree to and reduce hiding sites
- Early fruit harvesting when they are semi-ripened
- Fruit Bagging: Bagging fruits 55-60 days after flowering protects against fruit flies, mango seed weevils, and pests while improving skin appearance.
- Collect all infested fallen fruits around the farm into a plastic bag (solarisation) or an augmentorium
- Put the rotten fruit in a drum of water to drown the worms
- Harvest fruit at the mature-green stage

Non Chemical Control

- use of sticky traps every 20m (change weekly)
- Use Beauveria bassiana Strain R444 2.0×108 cfu/g
- Mass trapping (brewer's yeast in water placed in troughs 1 trap every 40m.
- Mass trap male flies using (methyl eugenol block + contact insecticide (commercially available)
- CERA TRAP (LiquidHydrolysed Protein 55g/L)
- Fruit fly Mania (Yeast extract hydrolysate 5%)

Chemical Control

- Apply Spinosad 0.24 g/3 days REI; 8 hours MRLs 0.02 mg/kg , PHI 3days
- BACTROLURE 98.9% LIQUID Methyl Eugenol 98.9%, MRLs 0.01 mg/kg

Mango Thrips (*Selenothrips rubrocinctus, Scirtothrips aurantii)*



Adult mango thrip
(Source: Lyle Buss University, Bugwood.org)



Thrips damage on mango fruit; rough, greyish, scars. *(http://www.spchcmc.vn/EN/Plant-doctor-Detail/Thrips-causing-damage-on-mango-5-8465.html)*



Thrip damage on Mango fruit and shoot
(Source: http://www.spchcmc.vn/EN/Plant-doctor)

Prevention

Monitor thrips presence/ population using sticky blue traps

Scouting for:

- Silvery sheen on young leaves caused by thrips feeding
- Tap foliage/flowers on to white paper (look nymphs with red bands on abdomen/black and elongate adults weekly

Take action when;

- Most leaves turn silvery, before they turn brown or look burnt
- Catches of 4-6 adults per flower

Monitoring

- Use pest free/ certified planting materials
- Field sanitation; weeding, removal and disposal of infested material
- Maintain good Soil moisture
- Avoid excessive application of nitrogen
- Plough/dig the soil to expose the pupae
- Prune the mango trees
- Conserve natural enemies lace wigs, ladybird beetles
- Establish windbreaks

Plant sorghum as a trap crop and , and Tithonia as a repellent

Non Chemical Control

- Mass trapping using sticky traps (blue or yellow sticky)8 traps per acre
- Application of insecticidal soap (10 teaspoon full of soap powder in 20l water)

Chemical Control

Application of:

- Abamectin 50 g/L (Alonze 50EC) MRL:0.01mg/kg PHI: 7days
- Sulfoxaflor 240g/L (closer 240 SC) EU MRL: 0.01mg/kg; PHI- 14 days

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Mango Stripped Mealybug (*Ferrisia virgata*)



Adult: Whitish body, two longitudinal dark stripes, long glassy wax threads, and two long tails *(Photo: INFONET Biovision)*



Mealybug colony on fruit stalk and White cottony (mealy) wax substance



Sticky honey-like substance (honeydew *(Photos: Ngugi CN, 2026 KALRO HRI)*

Prevention

- Source planting materials from reliable/certified nurseries
- Observe field sanitation: (Control weeds, proper disposal of infested materials- both pruned and fallen
- Remove alternate host plants, e.g., guava, citrus, and cassava
- Avoid the use of broad-spectrum pesticides to
- Conserve natural enemies (lacewings, lady beetles)

Monitoring

Scout for mealybug infestation throughout the plant growing period.

- Inspect 100 leaves from five different trees per acre
- Adults; oval-shaped, up to 5 mm long, with dark stripes on the back and two long, waxy tails

Check for:

- White cottony (mealy) wax substance on leaves during heavy infestations
- White, waxy cocoons remain on the plants
- Black powdery substance (Sooty mould on leaves
- Sticky colourless honey-like substance (honeydew)
- White, filamentous masses along plant tissues
- Take action when two or more of every ten leaves are infested

Non Chemical Control

- Introduce flowering strips, such as African marigold, to attract and sustain natural enemies
- Use physical barriers (plastic sheets and sticky bands) to trap nymphs and ants
- Apply ash to control ants that protect mealybugs
- Use a strong stream of water to blast off the pest during the early stages of infestation

Chemical Control

- Sulfoxaflor 240g/L (Closer 240 SC) EU MRL: 0.01mg/kg; PHI- 14 days

White Mango scale (*Aulacaspis tubercularis*)



Adult and immature females on a leaf
Photo credit: T. Kondo



Infestation on leaf
Photo credit: J. H. Lopez



Infestation on fruits
Photo credit: S. Sevgan

Prevention

- Avoid movement of infested plant materials from one place to another to prevent spread of the pest.
- Examine seedlings thoroughly before planting to ensure they are free from scale insects.
- Where possible, plants could be grown in a dedicated facility such as an insect proof greenhouse to prevent the infestation.
- Remove infested leaves and/or alternate hosts from near the main crop to eliminate sources of re-infestation.
- Wash, brush and clean farm equipment after use to prevent spread of the pest.
- Practice good orchard hygiene; prune off and burn infested plant material to avoid spread in the orchard.
- Where possible, use controlled temperature treatments aimed to kill or inactivate pests in consignments meant for exports
-

Monitoring

- Carefully examine plants and fruitsfor presence of pest
- Use yellow sticky traps to determine the presence of the winged adult males
- MPale crawlers settle in groups of 10–80, often near their mother and these groups are conspicuous due to the white scale covers produced.
- Check for pink blemishes on the infested mango fruit and chlorotic patches on the foliage which are easily detectable.

Non Chemical Control

- Use biological control of the species using recommended parasitoids and predators
- Minimise synthetic pesticides use to conserve these natural enemies
- Use neem extract or garlic oil to manage this pest.
- Practice IPM, integrating the different control strategies to achieve the best results.
- Apply a 2% horticultural (paraffinic mineral) oil solution when the early stages of crawlers and few adult stages are present. Spray the undersides of the leaves thoroughly. Repeat at monthly intervals.

Chemical Control

- Under heavy infestation, spot treat with synthetic insecticides
- Use insecticidal ant baits to prevent ants from protecting mealybugs from predators

Before using pesticides

- Always use approved registered pesticides for scale insects control.
- Use protective gear when using pesticides
- Follow the instructions on the product label before using any pesticide

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Mango Anthracnose (*Colletotrichum gleosporides) species Complex*



Mango fruits infected with anthracnose *(Photo: David Thuranira 2026, KALRO-HRI)*



Tear drop symptom on Mango fruit *(Photo: David Thuranira, 2026, KALRO-HRI)*



Marginal necrosis and leaf malformation caused by anthracnose *(Photo: David Thuranira, 2026, KALRO-HRI)*

Prevention

- Ensure you apply recommended agronomic practices (spacing, water and nutrient management
- Regularly prune the trees to remove excessive foliage in order to encourage air circulation in the tree canopy.
- Scout regularly to identify the disease early
- Plant seedlings free from the disease
- Remove and burn fallen plant debris around the base of the tree
- Stake up the low lying branches to prevent foliage and fruits from getting in contact with soil or debris
- At harvest handle the fruit carefully to prevent injuries
- Avoid harvesting fruits when its wet

Monitoring

- On ripe fruits brown to black sunken spots develop and cause extensive decay on the fruit. The symptoms are quiescent on immature fruits and often no symptoms are visible. However, infected fruits may abort prematurely
- Linear necrotic brown to black spots may appear on the fruit forming "tear drop" like symptoms. As the disease progresses, cracks may appear on the epidermis causing "Alligator-skin"
- On the leaves black to brown spots appear on the leaves. As the disease progresses these may coalesce to form large necrotic areas often along the leaf margin.
- Under severe infection the leaves may become misshapen.
- The necrotic spots also appear on panicles and twigs causing flower drop and twig die back respectively
- The symptoms are prevalent during humid and wet weather

Non Chemical

- Prune the diseased twigs and flowers and discard them burning or burying
- Collect the fallen fruits and discard them by burying.
- At the end of season remove and discard all infected left-over fruits from the tree canopy
- Ensure you apply appropriate pre-harvest handling practices such as pre cooling of fruits and well ventilated packaging

Chemical Control

Apply fungicide starting flower bud formation stage until early fruiting. Spray at interval 10-14 days depending on disease pressure and prevailing environmental conditions. Spray the tree with:

- Trifloxystrobin 100 g/L + Tebuconazole 200g/L based fungicide (Nativo 300SC at a rate of 10 ml/20 L, PHI 3 days, REI 12hours, MRL (EU) Trifloxystrobin 0.01mg/kg, Tebuconazole 0.1mg/kg , MRL (UK) Trifloxystrobin 0.01mg/kg, Tebuconazole 0.1mg/kg) or Triadimefon based fungicide (Bayleton WP 25 at 40g/20L, PHI 28 days, REI 6 hours, MRL (EU) 0.01mg/kg, MRL (UK) 0.01 mg/kg)
- or Copper Abietate based fungicide (MangoCopp 250EC at a rate 20ml/20L water, PHI, REI 12 hours, MRL (EU) 0.3mg/kg, MRL (UK) 20mg/kg)
- or Azoxystrobin 200g/L + Difenoconazole 125g/L (Token 325 SC, at a rate of 10ml/20l water, PHI 7 days, REI 8 hours, MRL (EU) Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg, MRL (UK) Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg
- Or Azoxystrobin 250 g/L + Difenoconazole 150 g/L (Absolute star 400SC at a rate 4ml/20l water, PHI 7 days, REI 8 hours, MRL (EU) Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg, MRL (UK) Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg

Alternate fungicides with different modes of action to reduce development of resistance

- Postharvest treatment of fruits with Fludioxonil based fungicide (Fastano 500SC at a rate of 250ml in 800L of water, PHI 5 days, REI 1 hour, Acceptable MRL (EU), 2mg/kg

Mango Powdery Mildew (*Pseudoidium anacardii*)



Mango inflorescence with a covering of white powdery growth (fungal mycelium *(Photo: David Thuranira, KALRO-HRI)*



Extensive necrosis and leaf curl on mango leaves infected with Powderly mildew *(Photo: David Thuranira, KALRO-HRI)*

Prevention

- Ensure you apply recommended agronomic practices (spacing, water and nutrient management)
- Regularly prune the trees to remove excessive foliage in order to encourage air circulation in the tree canopy.
- Scout regularly to identify the disease early
- Plant seedlings free from the disease
-

Monitoring

- White powdery growth (fungal mycelium) on mango inflorescence, leaves and twigs. Young leaves and inflorescence are most susceptible.
- Greyish, necrotic spots on the leaves. The spots may coalesce causing large necrotic areas
- Infected leaves become distorted and may shed off.
- Infected flowers wither, dry up causing extensive premature fruit drop
- The disease symptoms are prevalent under dry, cold weather accompanied by high humidity

Non Chemical

- Prune the diseased twigs and flowers and discard them burning or burying
- Collect the fallen fruits and discard them by burying.
- At the end of season remove and discard all infected left-over fruits from the tree canopy

Chemical Control

Apply fungicide starting flower bud formation stage until early fruiting. Spray at interval 10-14 days depending on disease pressure and prevailing environmental conditions. Spray the tree with:

- Tebuconazole 200g/L based fungicide (Nativo 300SC at a rate of 10 ml/20 L, PHI 3 days, REI 12hours, MRL (EU) Trifloxystrobin 0.01mg/kg, Tebuconazole 0.1mg/kg, MRL (UK) Trifloxystrobin 0.01mg/kg, Tebuconazole 0.1mg/kg)
- or Triadimefon based fungicide (Bayleton WP 25 at 40g/20L, PHI 28 days, REI 6 hours, MRL (EU) 0.01 mg/kg, MRL (UK) 0.01 mg/kg)
- or Copper Abietate based fungicide (MangoCopp 250EC at a rate 20ml/20L water, PHI, REI 12 hours, MRL (EU) 0.3 mg/kg, MRL (UK) 20mg/kg)
- or Azoxystrobin 200g/L + Difenoconazole 125g/L (Token 325 SC, at a rate of 10ml/20L water, PHI 7 days, REI 8 hours, MRL (EU) Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg, MRL (UK) Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg
- Azoxystrobin 250 g/L + Difenoconazole 150 g/L (Absolute star 400SC at a rate 4ml/20l water, PHI 7 days, REI 8 hours, MRL (EU) Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg, MRL (UK Azoxystrobin 4 mg/kg, Difenoconazole 0.1mg/kg
- Alternate fungicides with different modes of action to reduce development of resistance

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Mango stem end rot (*Botryosphaeri* genus)



Dark brown lesions at different stages of development on fruit stem base *(Photo: David Thuranira, KALRO-HRI)*

Internal rotting of mango fruit from the stem end *(Photo: P and Adikaram, 2020)*

Prevention

- Ensure you apply recommended agronomic practices (Spacing, water and nutrient management)
- Regularly prune the trees to remove excessive foliage in order to encourage air circulation in the tree canopy.
- Scout regularly to identify the disease early
- Plant seedlings free from the diseas

Monitoring

- Small dark brown to black lesion start at the base of fruit stem.
- The lesion gradually enlarge leading to a round dark brown to black rot around the base of fruit stem. The rot gradually extends to other parts of the fruit
- As the disease progresses, it penetrates into the pulp of the mango fruit causing extensive internal fruit rot.
- The symptoms are prevalent during humid and wet weather

Non Chemical

- Prune the diseased twigs and flowers and discard them burning or burying
- Collect the fallen fruits and discard them by burying.
- At the end of season, remove and discard all infected left-over fruits from the tree canopy
- Apply appropriate pre-harvest handling practices such as pre cooling of fruits and well ventilated packaging

Chemical Control

- There are no pre-harvest fungicides registered for the disease
- Postharvest treatment of fruits with Fludioxonil based fungicide (Fastano 500SC at a rate of 250ml in 800L of water, PHI 5 days, REI 1 hour, Acceptable MRL (EU), 2mg/kg

Mango Scab disease (*Elsinoe mangiferae*)



Scab infected mango fruit with small and large corky scabs
(Photo: Conde et al., 2007)



Scab infected leaves showing small black spots and distorted leaf margin
(Photo: Conde et al., 2007



Scab infected stem showing raised grey scab lesions
(Photo: Conde et al., 2007)

Prevention

- Ensure you apply recommended agronomic practices (spacing, water and nutrient management)
- Regularly prune the trees to remove excessive foliage in order to encourage air circulation in the tree canopy.
- Scout regularly to identify the disease early
- Plant seedlings free from the disease
-

Monitoring

- Initially starts as black spots on newly set fruit.
- As the disease progresses, brown scab or scar tissue develop. The individual scab lesions coalesce to form cracked corky lesions on the fruit surface.
- The scarred tissue do not develop into rot. However, they make the fruit unappealing to the consumers
- Premature fruit abortion.
- Numerous small black to brown spots with yellow halos appear on the leaves
- Brown to black corky elongated lesions on the lower side of the leaves. The corky lesions often appear along the main veins
- Leaves appear distorted due to lesions on the leaf margin
- Defoliation of the young leaves
- Small raised grey lesions that later develop into large light tan corky lesions on the stem, flower and fruit stalks

Non Chemical

- Prune the diseased twigs and flowers and discard them burning or burying
- Collect the fallen fruits and discard them by burying.
- At the end of season remove and discard all infected left-over fruits from the tree canopy

Chemical Control

- There are no fungicides registered for the disease

Mango Russeting (*Physiological disorder*)



Corky cracks on the surface of apple mango fruit affected by russeting disorder *(Photo: David Thuranira, KALRO-HRI)*

Signs and Symptoms

- Dull brown corky appearance on the fruit surface.
- Cracks on the fruit skin making the fruit unattractive
- The disorder is aggravated by mites and thrips damage
- The symptoms resemble damage caused by thrips or mites and are easily confused.
- The physiological disorder is common in apple variety especially when grown in high altitude areas. Higher severity and incidences have been reported under conditions of wet and cold night temperatures

Prevention

- Avoid growing susceptible varieties such as apple in the high altitude areas which are characterised by high rainfall and cold night temperatures
- Grow varieties that are less prune to the physiological disorder such as Kent, Tommy Atkins, Keitt

3.5. Harvesting and Post-Harvest Management

3.5.1 Harvesting of fresh mangoes

Harvesting starts 3-4 years after planting.

Mango is a climacteric fruit; ripening continues even after harvest. Therefore, if it's harvested too early, mango wrinkles without ever ripening properly. Maturity determines mango shelf-life and quality, if harvested too late, the shelf life is shortened making it difficult to be transported over long distances.

Mangoes should be harvested when physiologically mature but not ripe to ensure that the taste meets the UK consumers' preferences.

The type of transportation over long distance i.e airfreight or sea freight, determines the harvesting stage if the fresh mature managoes. Air-freighted mangoes may be harvested at a later stage compared to sea-freighted mangoes, which must be harvested earlier.

To check maturity, internal flesh colour, degree brix (sugar content), firmness, and shape (shoulder) is assessed. Additionally, the moisture content should be less than 80%.

Determining mango fruit maturity

Key Indicators of Physiological Maturity

- Skin colour: flesh changes from pale white to pale yellow, and the stone (seed) hardens.
- Most farmers assess mango maturity based on skin colour; however, this method is prone to human error.
- Shoulder: full rounded shoulders signals mango maturity.
- Firmness: Mango fruit firmness is an indicator of maturity level; it shows whether a mango is immature, mature, and overmature.

Degree Brix

- Degree Brix (sugar content) can be used to determine fruit maturity
- Brix refractometer measures sugar level in aqueous solutions. For mango, the Brix refractometer measures sugars in the mango juice. A mature green mango should have 14 or more Brix.-see Fig 22 for digital brix refractometer, and Fig 23 testing in the laboratory.
- Use either a destructive Brix refractometer that requires samples taken from the mango flesh or non-destructive Brix refractometer to measure the sugar content without digging into the mango flesh



Figure 22 – Digital Brix refractometer. *(Photo Courtesy: Sarah Ndegwa HCD laboratory JKIA Nairobi)*



Figure 23 – Digital Brix refractometer being used to test mango Brix, *(Photo Courtesy: Sarah Ndegwa HCD laboratory JKIA Nairobi)*

Horticultural Crops Regulation of 2020 Harvesting Requirements

The following Horticultural Crops Regulation of 2020 must be met before harvesting.

- Horticultural produce shall be harvested at the right stage of maturity for the intended use.
- Harvested produce shall be handled by personnel with skills and knowledge on food safety.
- Harvested produce shall be protected from dust and other contaminants
- Horticultural produce shall be harvested using clean crates or clean buckets.
- A collection shed shall be constructed for receiving produce at the field level and
- meet all the conditions set out in the Horticulture Regulation of 2020

Good harvesting practices for mango

Mechanical injuries that occur during harvesting, field handling and transportation are the major causes of postharvest quality losses. Other important causes of these losses include unmatured and over-ripe fruit, infection by postharvest diseases, physiological disorders, unfavourable storage temperatures and pest damage.

The following are good harvesting practices for mango:

- Harvest mangoes only when they attain physiological maturity
- Mango pickers should be proficient at harvesting and must observe good hygiene practices
- Observe consistent maturity
- Use non-destructive harvesting techniques such as harvesting by hand. For fruits unreachable by hand, use harvesting poles with nets and clean catching bag. Handle fruits carefully to prevent physical damage (bruising/ cuts), which can lead to fungal infections
- Do not harvest fruit when wet, e.g. during or after rains. Also, do not harvest when weather is hot if fruit cooling facilities are not available
- Once the latex is exhausted, harvested fruits should be placed into soft bags or plastic crates to prevent mechanical injuries, especially bruising to the fruits
- Avoid placing the fruits directly on the ground to avoid contamination by food borne pathogens surviving in the soil
- Do not wrap harvested fruits using banana leaves both at the orchard and during transportation
- Harvesting records must be kept as part (kgs, date of harvesting, batch etc)

DE-SAPPING

Desapping is a critical post-harvest process in mango production that involves removing the sap (latex) that oozes from the stem when the fruit is harvested. The primary importance of desapping lies in preventing significant quality deterioration and economic losses caused by sap burn, which appears as brown or black streaks on the fruit skin.

- Harvest with 10mm–15mm of stalk remaining
- Keep the fruit stalk-end down during transport to prevent latex from staining the skin

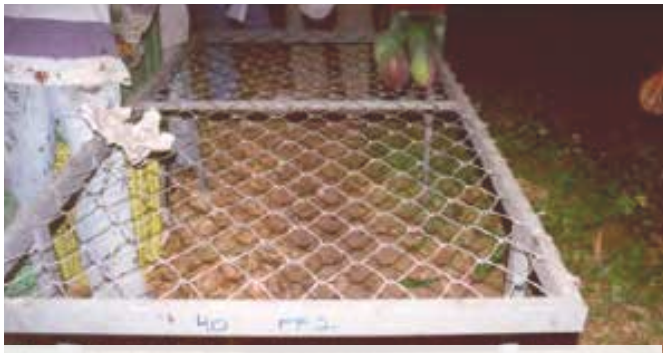
The peduncles are preferably cut to a length of 0.5 cm in the field, and peduncles are placed facing down to avoid staining the fruit with latex, because when a peduncle breaks during transport, all the surrounding fruit will be stained by the sap. The latex stops flowing after about 30 mins – see Fig 24 for desapping of freshly harvested mangoes, Fig 25 for latex stained fruit and Fig 26 Suberized stains due to resin exudation.



Mango peduncles cut using secateurs



About 0.5 cm of peduncle remianing



High de-sapping racks



Low de-sapping racks

Figure 24 – Desapping of freshly harvested mangoes. *(images adapted from COLEAD mango production guide, 2012)*



Figure 25 – Freshly harvested mango stained by latex. *Photo courtesy: Gaute Fresh*



Fig 26 – Suberized stains due to resin exudation – Limit allowed in class II. *Source: Mangoes | OECD*

3.5.2 Post harvest activities and packhouse processes

Packaging into transport crates

- Must be clean
- Mango crates should be labelled (crop, variety, harvest date, plating date etc) before loading onto transport vehicles to the packhouse. This ensures that traceability is maintained-see fig 27.



Fig 27 –Mangoes in crates at the orchard. *Photo courtesy of FPEAK*

Transportation from the orchard to aggregation centres and packhouses

Mechanical injuries can occur during harvesting, field handling, and transportation, are major causes of postharvest quality losses.

The following are good transportation practices when transporting mangoes from the orchard to the aggregation centre or to the packhouse:

- The fruits should not be exposed to the sun in vehicles hence covering with 80% shade-cloth or a fabric tarpaulin / canvas is recommended for vehicles without a roof.
- Refrigerated vehicles are recommended for the transportation of mangoes to the packing station.
- Plastic sheets should not be used because they create a warm and humid environment that accelerates ripening and sometimes fungal infections.
- Avoid the use of banana leaves to cover the crates for they produce ethylene gas which accelerates mango ripening and thereby reduces shelf-life.
- The trucks carrying the produce should be driven carefully on rough roads to minimize damage during transportation to the packhouse.
- Mangoes should not be transported with other produce to avoid cross-contamination.
- Fruits should be transported to cooling and aggregation centres to remove field heat.
- From aggregation centres, fruits should be transported in closed trucks preferably cooled trucks to pack houses.

Packhouse facility processes

Packaging facilities should comply to the Horticultural Crops Regulation 2020, which sets out the minimum conditions for produce handling facilities as follows:

- Have good lighting, well-aerated, and spacious
- the working areas and premises of a produce handling facility shall be kept free of waste materials
- Have rust-proof grading table and clean equipment in good condition
- Floor layout should allow for smooth flow of produce
- available clean and safe water for washing and cleaning operations
- Floors and doors shall be made of impervious material, which is easy to clean
- Facility shall not allow entry of dust and unwanted animals
- No person shall smoke or eat in the facility
- Appropriate signage shall be displayed
- Packaging material shall be kept off the floor
- Traceability of produce shall be documented
- Have a specification chart for sorting fruits
- All food handling personnel should be trained in basic hygiene, including HACCP
- All personnel handling food should be of sound health to avoid contamination
- Personnel should wear protective clothing and maintain high personal hygiene
- Install fruit fly traps in the packhouse to attract and kill any fruitflies in the packhouse

Generally, the following packing processes should be followed:

1. Fruit Reception
2. Pre-Cooling
3. Washing/ Cleaning
4. Post-Harvest Treatment
5. Sorting & Grading
6. Packaging
7. Labelling
8. Palletising
9. Cold Storage

Fruit reception at the packhouse

- unloading from the trucks, reception, and weighing.
- Upon delivery to the packhouse, the crates should be transferred immediately to a cool, shaded area inside the packhouse.
- Initial verification of fruit condition (this will determine the next steps) and verification of the number of crates by the packhouse staff.
- Packhouse staff should ascertain that the mangoes are of uniform variety – see fig 28 below.
- Packhouse reception staff should control the presence, severity and percentage incidence of:
  - insect or pest-damaged fruits
  - diseased fruits (anthracnose, stem-end rot, etc.)
  - fruit injuries caused by rough handling during harvest or transport e.g. cuts or gashes to fruits, fingernail scratches)
  - fruits without peduncle



Fig 28 – Mango fruits in crates at the packhouse. *Phoot credit: FPEAK*



Fig 29 Checking of fresh mango quality at packhouse. *Photo credit: KEITT*

Pre-Cooling

On arrival at the packing station, the fruits must be pre-cooled to about 12°C – 13°C to remove the field heat. The cooling room/facility should:

- Be clean and sanitise the facility walls, ceilings, doors, and racks. To ensure easy cleaning, the structures must be smooth and non-absorbent
- Condensation from cooling units should drain directly into the drain and not onto the floor. Listeria build-up and risks may increase in cold, wet niches
- Walls and floors must be kept as dry as possible
- Add a slow-release disinfectant to the pan to keep microbial growth at a minimum and prevent
- Drainage lines must be maintained to prevent clogging and overflowing onto boxes of produce
- A daily temperature log of fruits in the cold room should always be maintained

Washing/Cleaning

- Fruits should be cleaned with clean water to remove field dust, plant debris, pests etc. Fruit cleaning can be achieved in different ways depending on the sophistication of the available equipment, see Fig 30 below.
- Regardless of the technique used, the water should be changed regularly, especially when the peduncles are cut at the facility. On modern packaging lines, the fruit is not washed but sprayed with a high-pressure jet.
- After soaking, the fruit is brushed to remove any impurities on its surface.



Fig 30 – Picture of mango fruits being washed at the packhouse. *Photo credit: FPEAK*

Sorting and Grading

Sorting helps identify and remove mangoes with unacceptable size, maturity stage, defects, pests or pest damage, over- or under-ripe mangoes, skin damage (bruises), sunburn, deformations, etc. Physiological defects are mainly identified by touching the fruit, but they are not easy to detect.

The fruit is sorted manually or with the assistance of machinery. A specification chart should be provided to the packhouse personnel to help inspect, grade, sort, and pack mangoes consistently according to UK export market (client) requirements – se section on Mango quality requirements.

Post-harvest treatment

Depending on the customer requirements, the exporter may choose to wax the fruits and apply approved phytosanitary measures against mango fruit fly (*Bactrocera dorsalis*, *Ceratitis capitata*, and *Ceratitis cosyra*).

When conducting post-harvest treatment using any product, it is important to read the labels and follow the recommended doses.

Waxing

Heat treatment may have a negative effect on the appearance of the skin of mangoes. Applying food-grade wax and polishing the fruit gives the mangoes a shiny finish. The waxes are manufactured using synthetic or natural products.

Waxing of treated fruits is beneficial in that the wax coating prevents loss of moisture and consequently the weight of the fruits.

Note that not all export markets require waxing. Always check your customer preferences.

Vapour heat treatment (VHT) facility

Vapour Heat Treatment offers phytosanitary treatment to comply with various markets on mango fruit fly (*Bactrocera dorsalis*, *Ceratitis capitata*, and *Ceratitis cosyra*). See the Vapour Heat Treatment SOP in Annex 5.9 . The following are required:

- VHT facility must be inspected and approved by KEPHIS
- Fruits to be treated must be mature and of same variety – see Fig 31
- VHT temperature parameters maintained at 46–48°C for mango fruits
- Relative humidity maintained as prescribed
- Total heat vapour exposure not exceeding 4 hours
- Continuous monitoring throughout treatment
- Treated produce clearly identified and segregated from untreated produce
- Traceability of the facility and treatments undertaken must be maintained
- Post-treatment area kept clean and pest-free
- Measures in place to prevent infestation or re-infestation



Fig 31 – Inspecting for quality before Vapour Heat Treatment. *Photo credit: KEPHIS*

Packaging

The fruits are categorised by size and grade and placed into 4kg or 5kg boxes (the number held by a box depends on the mango sizes).



Fig 32: Packed Tommy Atkins. *Photo courtesy of FPEAK*

Labelling

- Every packaging material for horticultural produce for the export market shall be branded as "Produce of Kenya" using the national logo prescribed by Kenya Export Promotion and Branding Agency (KEPROBA), the national institution responsible for branding.
- In order to comply with the Codex General Standard for the Labelling of Prepackaged Foods (CODEX STAN 1-1985) the following additional information may be added to the labels:
  - Product name
  - Categories of fruit
  - Size of fruit
  - Variety name
  - Packing date
  - Country of origin
  - Destination country
  - Name and address of customer/Client
  - Name and address of the exporter
  - Storage or conservation conditions
  - Nutritional value (composition, energy value)
  - Instructions for use

Palletizing

Wooden pallets are commonly used for stacking packed mango boxes. Wooden pallets must be heat treated at a Heat Treatment facility approved by KEPHIS – see in figure 21 below

Ensure the wooden pallets are placed on a secure surface off the packhouse floor.

Strapping at the bottom, middle and top of staked boxes is recommended to reduce collapsing of the pallet and packed mango fruits injury.

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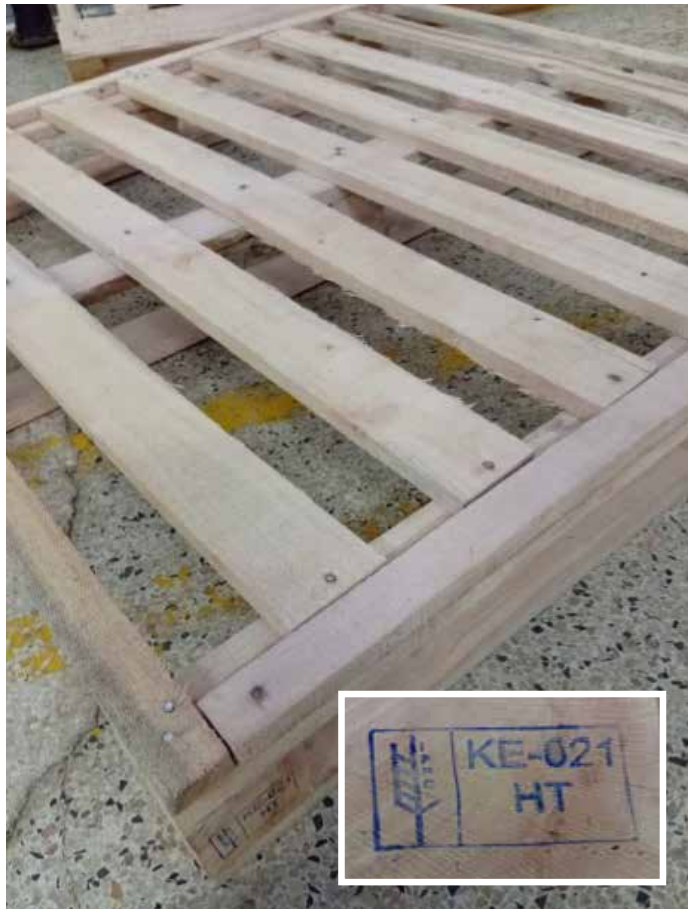


Figure 33 – Heat treated wood pallet with official Heat Treatment Mark. *Photo credit: FPEAK*

Pre-shipment Cooling

- To slow the respiration and metabolism of the mango fruit, after pelletizing, mangos should be cooled to 12°C for mature green mangos. Temperatures below 12°C may lead to chilling injury in mature green mangos. The extent of chilling injury is dependent on exposure time and temperature.

This can be done through:

Room Cooling

Palletised mangoes may require 24-48 hours to attain room cooling. In this cooling method, refrigerated air contacts pallet surfaces while the heat from the pallet is conducted to the storage room surface.

Forced Air cooling

Forced-air (or 'pressure') cooling cools the palletized mangoes rapidly compared to room cooling. Optimally designed forced-air cooling systems can lower mango temperatures from 30°C to 40°C to around 12 to 15°C within 2 to 4 hours.

Hydrocooling

Hydrocooling is the most rapid cooling method; it entails removing heat by immersing mangoes in cold water. This technique presents logistical challenges as well as risks of transferring decay pathogens from the water to the fruit.

3.6. Inspection for export

This is a mandatory phytosanitary certification for all exports of fresh mango fruits to all destinations is a requirement, notwithstanding the United Kingdom's current classification of fresh mangoes as a low-risk product that does not require a phytosanitary certificate for import. It supports pest risk management, particularly for pests of economic and quarantine significance, ensures traceability and compliance, and aligns with international best practices in plant health protection. The continued issuance of phytosanitary certificates under this protocol, therefore, ensures compliance with Kenyan regulatory requirements, supports the integrity of mango exports to the UK, and safeguards Kenya's long-term market access.

All mango fresh exports must be inspected by KEPHIS.

Fresh mango Commodity Inspection

- Commodity inspection is conducted by KEPHIS for phytosanitary compliance and AFA for quality assurance. **Refer to Packhouse phytosanitary sampling and inspection protocol for fresh mango fruits exported to the United Kingdom**
- The packhouse where the commodity will be inspected must be a registered and approved facility by AFA and KEPHIS
- KEPHIS conducts inspections at the packhouse or point of exits
- Sampling is carried out in accordance with international standards (e.g. ISPM guidelines)
- Inspections assess:
  - Presence of live pests
  - Symptoms of pest or disease infestation
  - Any signs of contamination
  - Compliance with export quality standards
- Compliant consignments are issued with a phytosanitary certificate
- Non-compliant consignments are rejected and issued with a rejection notification

NB: Phytosanitary certificates are issued through the IEICS platform.

3.7. Determination of Risk Levels and Proposals or Appropriate Control Measures

This analysis of the level of risk of each hazard recognized as relevant in the mango value chain, follows the analysis of the hazards identified in the diagrams for the stages at which they may appear and cause more or less serious harm, whether or not avoidable. This hazard analysis will be revised when one of the elements that have been considered is modified (regulatory evolution, change in production practices, etc).

Hazard / Risk Ranking (Threat) Matrix (Risk characterization matrix for Food safety parameters)

		Likelihood (L)		
	Ranking Scorer	**1 Very unlikely**	**2 Likely**	**3 Very Likely**
Severity (S)	3 Major	3	6	9
	2 Moderate	2	4	6
	1 Minor	1	2	3

Key: Hazard / Risk Tolerance – Levels of risk characterization:

Score < 4: low risk = Good Working Practices programmes (GWP) required prerequisite: maintain compliance with all "Good Practices" (e.g. GHP, GAP, as appropriate).

Score of 4: moderate risk = Point of Attention (PA): for tolerable – preventive measures and regular monitoring (checks) will have to be put in place OR Control Point (CP) for intolerable

Score > 4: high risk = Control Point (CP) or Critical Control Point (CCP): control measures accompanied by checks will be essential and emergency action must be provided for in the event of non-compliance detected (e.g., exceeding the MRL).

1 – 3 = Low Risk	Green	**RECOMMENDATION** Insignificant hazard – Tolerable – No action	Controlled by GWP
4 = Medium risk	Yellow	**MINOR** Tolerable- Controlled by PRP's if Chemical or Physical hazard or quality related issue Intolerable- Controlled in SPS Control plan if Biological hazard or quality related issue	Controlled by PA for tolerable and CP for intolerable
6 – 9 = High Risk	Red	**MAJOR for Food safety** Intolerable – Controlled in SPS Control plan	Controlled by CCP

When, for this high risk for food safety parameter, a CCP (Critical Control Point) is determined, **a control measure accompanied by a specific self-check is mandatory**.

Determination of risk levels for each hazard according to the stages (general production, processing and packaging scheme):

Hazard analysis

Production operations and hazard analysis at the Nursery

The following table (Table 14) describes for each operation step at the nursery, the analysis and categorization of potential quality dangers, plant health and food safety hazards that can affect fresh mangoes, including recommended control measures at each step;

Table14 – Hazard analysis worksheet for nursery operations

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Site selection	Heavy metals (Lead, mercury) Radiological hazards (e.g. cadmium)	Environmental hazard Industrial waste Previous usage of pest control products and inputs	2	1	Recommendation	Possible contamination of the soil with heavy metals from industrial wastes, flooding and previous usage of pest control products	Establish history of the soil Carry out a systematic analysis of the sanitary quality of the soil (volcanic soil) - Soil testing for heavy metals.	GWP
Potting mix preparation	Chemical hazards	Materials hazards - Presence of heavy metals in fertilizers and manure	1	1	Recommendation	Possibility of using soil amendment products that are not approved	Use of approved soil amendment products	GWP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Crop & Pest management	Heavy metals, High Pesticide residues > MRL	Labour-related hazards Over application of PPPs – Improper application of PPPs, Chemical penetration, Un even distribution of PPPs Hazards related to the raw material: Use of unapproved chemical – No systematic analysis of the of fertilizers used, – Lack of quality control of the fertilizer and manure used Dangers related to working methods Used of unapproved chemical – Due to pest pressure, farmers are likely to apply more chemicals than required Over application and spray drift -inadvertent use of pesticides Use of unapproved chemical Not observing preharvest interval	2	1	Recommndation	Farmers tend to overuse or improperly use /apply PPPs (Over-application of pest control products) Some farmers use pest control products that are not approved or not checked for quality by Competent Authorities Improper pruning practices that result in dense canopy Some farmers use pest control products that are not approved.	Training of personnel on proper application of PPPs and adherence of PPPs application guidelines Training on personnel on proper pruning practices and use of pruning guides (Orchard management practices) No intercropping Use of only approved or recommended pest control products. GAP	GWP

Hazard analysis worksheet for seedbed operations

The following table (Table 15) describes for each step, the essential unit operations to grow mangoes, the associated potential hazards and control/preventive measures:

Table15 – Hazard analysis worksheet for seedbed operations

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Site selection	Heavy metals (Lead, mercury) Radiological hazards (e.g. cadmium)	Environmental hazard Industrial waste Previous usage of pest control products and inputs flooding	3	1	Recommendation	Possible contamination of the soil with heavy metals from industrial wastes, flooding and previous usage of pest control products	Establish history of seedbed - Soil testing for heavy metals before land use, if higher than the following values; Cadmium – 0.8mg/kg, Chromium – 100mg/kg, Copper – 100mg/kg, Lead – 50-85mg/kg and Nickel 50mg/kg, abandon the field.	GWP
	Toxic chemicals and particles residues like smoke or dust on fruit	Contamination from the surrounding areas with dust, smoke or other contaminants	2	1	Recommendation	Most orchards are located away from industrial contaminated areas	Proper hygiene on planting sites in buildings and premises Proper Site selection	GWP
Land preparation	Pesticide residues)	Materials hazards use of herbicides	2	1	Recommendation	Indiscriminate use of herbicides for clearing land	Integrated weed management Use of approved/registered herbicides in clearing the land	GWP
	Heavy metals (Cadmium, lead, mercury)	Hazards related to the raw material Presence of heavy metals in certain mineral materials	3	1	Recommendation	Lime used in soil amendments and other soil amendment products that contain heavy metals	Use approved/registered lime, organic materials, fertilizer, and pest control products Ensure there is no high weed pressure in orchards that encourages intensive use of herbicides at planting	GWP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Planting	Biological hazards (Pathogenic microbes)	Materials hazards Pathogens in raw manure Labour-related hazards Personnel used for planting	1	3	Recommendation	Some farmers use farm manure that is not well composed Some farmers do not provide toilet facilities for their workers	Use of decomposed manure Providing toilets at the farm for workers Fencing Compliance with GAPs	GWP
	Heavy metals (Arsenic, lead, mercury)	Materials hazards - Presence of heavy metals in certain fertilizers and manure	3	1	Recommendation	Few farmers use chemicals during planting Possible exceeding of the maximum MRL levels Lime used in soil amendments not tested or confirmed for quality safety	Use of approved or registered products Use approved/registered lime, organic materials, fertilizer, and pest control products GAP	GWP
	Pesticide residues	Materials hazards Use of pest control products at planting Dangers related to working methods: Pest control products	1	1	Recommendation	Possible residues may not exceed the maximum MRL levels	Use of approved/registered products (see table 6) GAP	GWP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Irrigation	Pathogenic microbes	Labour-related hazards Personnel used for irrigation Hazards related to the raw material: From contaminated water	2	1	Recommendation	Some farmers do not have or provide toilet facilities for their workers No systematic analysis of irrigation water, lack of proper hygiene in the water storage facilities, lack of quality control of irrigation water Irrigation occurs throughout the crop cycle including the harvesting period hence would be a possible problem of cross-contamination during harvesting period	Training of workers on proper health and hygiene practices to ensure compliance with GAP/GHP. Proper hygiene in the water storage facilities Periodic water testing (Water quality checks) Covering/fencing of the water source / catchment area Preference for drip irrigation over overhead irrigation Providing toilets at the farm for farmers and their workers Fencing GAPs	GWP
	Pesticide residues	Dangers related to working methods Run-off -Presence of heavy metals in irrigation water Flooding (Fertilizer application in the neigh-boring farms)	2	1	Recommendation	Few farmers use chemicals during planting Possible exceeding of the maximum MRL levels	Avoid use of run-off water for irrigation Ensure correct type, method of irrigation and time of irrigation (avoid overhead irrigation during harvesting period) Use of approved products GAP	GWP
	Heavy metals	Flooding, run-off and contamination of water with heavy metals	3	1	Recommendation	Most farming activities undertaken in areas with minimal industrial wastes or environmental contamination	Water testing Covering and fencing of the water source /catchment area GAP	GWP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Fertilizer and Manure application	Pathogenic microbes	Labour-related hazards Contamination from Personnel used for fertilizer application	2	1	Recommendation	Some farmers do not provide toilet facilities for their workers	Providing toilets at the farm for workers Fencing Compliance with GHP and GAPs	GWP
	Heavy metals from contaminated fertilizer and manure	Hazards related to the raw material: Lack of systematic analysis or manure of the of fertilizers used Lack of quality control of fertilizer and manure used Improper fertilization	3	1	Recommendation	Most fertilizers used are approved for quality and checked for any contamination by Competent Authorities	Good agricultural practices	GWP
	Pathogens	Dangers related to working methods: From raw manure Risky phytosanitary practices: practice of use of undecomposed manure near harvesting period	2	2	Minor	Some farmers use undecomposed manure	Use of well decomposed manure GAP	PA
Scouting for pests and diseases	- Plant pathogens resulting into fruit rot - Presence of pests in fruits	Labour-related hazards - Scouting not done properly or early enough to identify pests and diseases in good time - Lack of knowledge on pests and diseases	3	2	Major	-Scouting personnel not trained on pest diagnostic -Scouting not done correctly to identify pests and diseases of concern	Proper scouting regime Training of personnel	CCP
	Pathogen and virus	Scouting materials such as hand lenses, scissors	2	1	Recommendation	Spreading of pathogens when equipment is not disinfected	Maintenance of field equipment Good agricultural practices	GWP
	Dangers related to working methods Pathogen and virus	Scouting materials such as hand lenses, scissors - Lack of proper management or use of scouting equipment	2	1	Recommendation	Spreading of pathogens when equipment is not disinfected	Maintenance of field equipment	GWP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Crop protection treatment	Heavy metals, High Pesticide residues > MRL	Labour-related hazards Over application of PPPs – Improper application of PPPs, Chemical penetration, Un even distribution of PPPs, intercropping with other crops Hazards related to the raw material: Use of unapproved chemical – No systematic analysis of the of fertilizers used, – Lack of quality control of the fertilizer and manure used Dangers related to working methods Used of unapproved chemical – Due to pest pressure, farmers are likely to apply more chemicals than required Over application and spray drift -inadvertent use of pesticides Use of unapproved chemical Not observing preharvest interval	3	2	Major	Farmers tend to overuse or improperly use /apply PPPs (Over-application of pest control products) Some farmers use pest control products that are not approved or not checked for quality by Competent Authorities Improper pruning practices that result in dense canopy Intercropping with other Crops that may require intensive use of PPPs Some farmers use pest control products that are not approved. Lack of observation of pre-harvest interval	Training of personnel on proper application of PPPs and adherence of PPPs application guidelines Training on personnel on proper pruning practices and use of pruning guides (Orchard management practices) No intercropping Use of only approved or recommended pest control products. GAP	CCP
	Presence of pests on fruit	Poor control of target pests – Un even distribution of PPPs	3	2	Major	Due to improper application of PPPs resulting in high pest population	Discard affected fruit if presence of pests is observed Training of personnel on proper safe use of pesticides Provide list of pests affecting mangoes and their signs and symptoms e.g photosheets Adoption of IPM practices for management of pests Proper application of approved PPPs Use of low risk PPPs e.g biopesticides GAPs	CP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Pruning	Pests and diseases in fruits	Materials hazards Unsensitized equipment Use of – unsanisitized equipment	3	2	Major	Possibility of cross contamination resulting in bacterial wilt and other pests/ diseases such a viruses	Disinfecting and sanitizing of pruning materials Use of the appropriate pruning equipment	CP
	Injury of the mango that could result in death of plant Bushy mango trees	Materials hazards Use of inappropriate pruning equipment – Lack of proper equipment for pruning Dangers related to working methods Poor pruning practices e.g., not covering the wound resulting in infection of the tree – Improper pruning	2	2	Minor	Wrong pruning equipment that could result in damage of the mango stems and branches Poor pruning practices e.g., not covering the wound resulting in infection of the tree	Use of appropriate tools that are well maintained e.g. in terms of sharpness Training of personnel on proper pruning practices	CP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Harvesting	Toxic chemicals and particles residues like smoke or dust	Environmental Hazards Contamination from the surrounding areas with dust, smoke or other contaminants – fields located in a polluted area	2	1	Recommendation	Most mango fields are located away from industrial contaminated areas	Proper Site selection	GWP
	Pathogenic microorganisms such as E. coli, Salmonella	Labour-related and material hazards • Harvesting Personnel used – Lack of compliance with GHP by staff Lack of control over health status – Lack of water for hand washing • Unclean harvesting equipment and materials such as creates and harvesting containers Dangers related to working methods • Poor fruit handling practices and lack of harvesting tools and equipment • Lack of knowledge of harvesting method • Placing fruits on the ground or soil • Harvesting at height	3	1	Recommendation	Poor hygiene practices by personnel used in harvesting Spreading of pathogens when unclean equipment that are not disinfected are used during harvesting Placing of fruits on contaminated soil A number of farmers do not have proper or adequate harvesting tools and equipment	Providing toilets at the farm for workers and hand washing stations in the farm. Proper cleaning and disinfection of harvesting equipment, creates and containers Using the right equipment and tools for harvesting to avoid fruit touching the ground, e.g., use of crates, buckets and motorized equipment Training of personnel on proper health and hygiene practices to ensure compliance with GAP/GHP. Training of harvesters on proper practices of handling and harvesting Fencing	GWP
	Pesticide residues > MRL	Labour-related hazards Non-observation of PHI at harvesting Spray drift from application of pesticides for another crop nearby the field e.g maize, and other vegetables	3	2	Major	Lack of observation of pre-harvest interval Intercropping with other Crops that may require intensive use of PPPs	Observation of PHI Training of personnel on the proper application of PPPs and adherence to PPPs application guidelines Training farmers and field workers including harvesters on good harvesting practices GAP	CCP
	Chemical contamination with oil, lubricants, fertilizers and pesticides	Materials hazards • Oil and lubricants from moving parts of machines • Use of unclean fertilizer bags and containers Non-disinfected fruit harvesting equipment	3	2	Major	Some farmers use sacks or containers that previously were used for fertilizer, pesticides or paints etc. Field equipment may not be in good state of repair	Use of clean recommended containers, fruit harvesting e.g crates GAPs	CCP

(1) Step	Hazard description		Hazard evaluation				Control Measures	
	(2) Hazards/dangers introduced, present or enhanced at this step	(3) Origin or source of the hazard or danger (according to the 5M method)	(4) Severity/ Impact of effect	(5) Likelihood of occurrence	(6) Recomm- ended level of requirement	(7) Justify decision for column (6)	(8) Control measure(s) applied to significantly minimize or prevent the hazard	(9) GWP, PA, CP, or CCP
Transport to aggregation centres/ packhouse	Chemical contamination with oil, lubricants and other chemicals from the vehicles Toxic chemicals and particles residues like smoke or dust from the vehicles	Environmental Hazards Contamination from dirty surfaces in the vehicles and the exhaust fumes – Dirty transportation vehicles Not well-maintained vehicles Materials hazards Use of dirty vehicles General lack of equipment maintenance Non-disinfected fruit harvesting equipment e.g crates	2	2	Minor	Most vehicles used for transportation are not in a good state Some farmers use dirty sacks and containers in dirty vehicles that previously were used for transportation of other materials that could be contaminants e.g. fertilizer or pesticides etc.	Use of clean sanitized surfaces in transport vehicles, Vehicles covered and avoid use of banana leaves Use of crates for holding fruit Use of clean recommended containers and crates Use of clean vehicles that are in good state of repair and that are closed GAPs	PA
	Pathogenic microorganisms such as E. coli, Salmonella	Material hazards and dangers related to working methods Unclean sacks, crates and containers, unclean vehicles Placing of fruits on the floor of the vehicle or using dirty container If vehicle was used for transportation uncleaned materials prior to loading fruit. • Due to poor transportation practices • Bulk transporting • Delay in transport to the market or packhouse • ransport over long distances Labour-related hazards Personnel handling fruit/crates with dirty hands – Lack of compliance with GHP by staff, Lack of control over health status, Lack of water for hand washing or cleaning of crates	2	2	Minor	Spreading of pathogens when unclean equipment that are not disinfected are used during transportation Contaminated product contact surfaces (vehicle or containers) Poor hygiene practices by personnel used in Transportation	Proper cleaning and disinfection of crates and containers used during transportation, and clean vehicles Proper sanitation of product contact surfaces Providing hand washing facility Have a cleaning programme for fruit holding containers GAPs	PA

The following table (Table 16) describes for each process step, the essential unit operations to package the products, the associated potential hazards and the preventive controls

Table 16 – Hazard analysis worksheet for packhouse

(1) Ingredient/ Processing Step	Hazard description		Hazard evaluation				Preventive control(s)	
	(2) Hazards/dangers introduced, present or enhanced at this step (according to the 5 M method)	(3) Origin or source of the hazard or danger	(4) Severity / Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for column (7)	(8) Control measure(s) applied to significantly minimize or prevent the hazard or danger	(9) GWP, PA, CP, or CCP
Fruit reception at aggregation centres/ packhouse	Toxic chemicals and particle residues like dust	Environmental Hazards Contamination from the surrounding areas with dust or other contaminants packhouse	2	1	Recommendation	Some packhouse are located in industrial contaminated areas	Enclosed/protected fruit during delivery to packhouse GHP	GWP
	Pathogenic microorganisms such as E. coli, Salmonella	Labour-related hazards No respect of basic hygiene rules by personnel Lack of compliance with GHP by staff Lack of proper personnel hygiene practices Lack of hand-washing stations Materials hazards Unclean containers such as crates Non-disinfected fruit holding containers like crates Unclean weighing balances at the open market/ packhouse /supermarket Dangers related to working methods Placing of fruits on the floor during unloading and using dirty container – Due to poor handling practices or too long time to deliver	3	2	Major	Poor hygiene practices by personnel used Spreading of pathogens when unclean containers that are not disinfected are used for holding fruits Contaminated product contact surfaces (e.g., containers)	Providing toilets at the Packhouse for workers and hand washing stations Personnel health checks Visitor control and declaration (see Record sheet 13) Proper cleaning and disinfection of Containers used for holding fruits Proper sanitation of product contact surfaces Place fruit in crates on pallets raised off the floor GHP	CCP
	Chemical contamination with oil, lubricants	Materials hazards Oil and lubricants from moving parts of handcarts/mikokoteni, or machines Use of unclean containers General lack of equipment maintenance	2	2	Minor	Dirty containers used for holding fruit	Use of clean recommended containers and crates GHPs	GWP
	Chemical hazards	Dirty floor which may contain chemicals	3	1	Recommendation	Contaminated product contact surfaces (e.g., floor or containers)	Place fruit in crates on pallets raised off the floor Proper sanitation of product contact surfaces	GWP

(1) Ingredient/ Processing Step	Hazard description		Hazard evaluation				Preventive control(s)	
	(2) Hazards/dangers introduced, present or enhanced at this step (according to the 5 M method)	(3) Origin or source of the hazard or danger	(4) Severity / Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for column (7)	(8) Control measure(s) applied to significantly minimize or prevent the hazard or danger	(9) GWP, PA, CP, or CCP
Temporary storage	Physical damage to fruit	Environmental Hazards -Heat buildup - Piling of fruits - Delayed before processing - Premature ripening	3	1	Recommendation	Fruits stored in warm temperatures may exacerbate rotting	Monitor receiving temperature Store in a cool area before processing to remove the field heat Pack fruits as soon as possible	GWP
	Pathogenic microorganisms such as E. coli, Salmonella	Labour-related hazards No respect for hygiene rules by Personnel Lack of compliance with GHP by sellers/ workers at aggregation centres and packhouse Lack of proper personnel hygiene practices Lack of hand-washing stations	3	1	Recommendation	Poor hygiene practices by personnel used	Providing toilets at the Packhouse for workers and hand washing stations GHPs	GWP
	Chemical contamination with oil, lubricants	Materials hazards Use of unclean containers	2	2	Minor	Dirty containers used for holding fruit	Use of clean recommended containers and crates GHPs	PA
	Pathogens	Materials hazards Unclean containers, such as creates -Non-disinfected fruit holding containers like crates	3	1	Recommendation	Spreading of pathogens when unclean containers that are not disinfected are used for holding fruits	Proper cleaning and disinfection of Containers used for holding fruits GHP	GWP
	Pathogen and other physical hazards	Dangers related to working methods Holding of fruits for long period leading to multiplication of pathogens, use of dirty containers – Due to poor handling practices - Delays before processing	3	1	Recommendation	Contaminated product contact surfaces (e.g., containers)	Proper sanitation of product contact surfaces Not holding fruit for long before processing and holding the fruits in cool clean storage areas GHP	GWP
	Chemical hazards	Dirty floor, which may contain chemicals	3	1	Recommendation	Contaminated product contact surfaces (e.g., floor or containers)	Proper sanitation of product contact surfaces	GWP

(1) Ingredient/ Processing Step	Hazard description		Hazard evaluation				Preventive control(s)	
	(2) Hazards/dangers introduced, present or enhanced at this step (according to the 5 M method)	(3) Origin or source of the hazard or danger	(4) Severity / Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for column (7)	(8) Control measure(s) applied to significantly minimize or prevent the hazard or danger	(9) GWP, PA, CP, or CCP
Washing and treatment	Harmful chemicals	Environmental Hazards Dirty or untreated water used in the open market/ packhouse /supermarket	3	1	Recommendation	Aggregation centres/ packhouse may not use potable water, some may use borehole	Use potable water, tests for water quality If treated use approved products	GWP
	Pathogenic microorganisms such as E. coli, Salmonella	Environmental Hazards Dirty or untreated water used in the open market/ packhouse /supermarket Labour-related hazards Personnel used for handling at washing station Lack of compliance with GHP by staff Lack of control over health status Lack of hand-washing stations Materials hazards Unsanitized brushes used in cleaning of fruit and conveyor belts and other fruit contact surfaces – Poor maintenance of cleaning brushes Hazards related to the raw material Contaminated water – Dirty washing facility Dangers related to working methods - Not changing water frequently	3	2	Major	Poor hygiene practices by personnel used Dirty brushed that are not well maintained Use of untreated water Prolonged use of washing water Not changing water frequently as required	Providing toilets at the aggregation centres/packhouse for workers and hand washing stations Cleaning and good maintenance of cleaning brushes for processing mango fruits Use of portable water Change of water after every shift Change of water after every shift GHP	CCP
	Chemical hazards	Hazards related to the raw material Residue of PPPs used to control fungi and bacterial diseases, Overuse of chemicals or use of wrong chemicals	3	2	Major	Possible overuse of chemicals during washing or wrong chemicals used	Use the recommended chemical additives at the recommended rate Calibration of equipment	CCP

(1) Ingredient/ Processing Step	Hazard description		Hazard evaluation				Preventive control(s)	
	(2) Hazards/dangers introduced, present or enhanced at this step (according to the 5 M method)	(3) Origin or source of the hazard or danger	(4) Severity / Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for column (7)	(8) Control measure(s) applied to significantly minimize or prevent the hazard or danger	(9) GWP, PA, CP, or CCP
Sorting and grading	Pathogenic microorganisms such as E. coli, Salmonella	Labour-related hazards Lack of compliance with GHP by food handlers Lack of control over health status Lack of or non-proper use of hand-washing stations Materials hazards Unsanitized food contact surfaces -Poor maintenance of the machines -Dirty washing brushes, prolonged use of brushes without washing them	3	2	Major	Poor hygiene practices by personnel used considering that the fruit will not be cleaned further Dirty surfaces used for conveying fruits during grading	Providing hand washing stations at convenient locations Personnel health checks Protective clothing provided GHPs Cleaning and good maintenance of food contact surfaces, machinery and cleaning brushes	CCP

(1) Ingredient/ Processing Step	Hazard description		Hazard evaluation				Preventive control(s)	
	(2) Hazards/dangers introduced, present or enhanced at this step (according to the 5 M method)	(3) Origin or source of the hazard or danger	(4) Severity / Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for column (7)	(8) Control measure(s) applied to significantly minimize or prevent the hazard or danger	(9) GWP, PA, CP, or CCP
Processing of mangoes	Pathogenic microorganisms such as E. coli, Salmonella	Labour-related hazards Lack of compliance with GHP by food handlers Lack of control over health status -Lack of hand-water stations Materials hazards Unsanitized food contact surfaces Use of unclean cartons Dangers related to working methods Contamination from poor handling places e.g., placing on dirty floor	3	2	Major	Poor hygiene practices by personnel used considering that the fruit will not be cleaned further Dirty surfaces used for conveying fruits during drying Contamination from poor handling places e.g., placing on dirty floor	Providing hand washing stations at convenient locations Good Hygiene practices Cleaning and good maintenance of food contact surfaces and cartons Good handling practices Weigh cartons	CCP
	Chemical contamination with oil, lubricants	Materials hazards Oil and lubricants from moving parts of fort-lifts or machines Use of unclean cartons -Poor maintenance of the machines - General lack of equipment maintenance	2	1	Recommendation	- Poor maintenance of machinery - Use of dirty or contaminated cartons	Use of clean recommended cartons Proper maintenance of machinery GMPs	GWP

(1) Ingredient/ Processing Step	Hazard description		Hazard evaluation			
	(2) Hazards/dangers introduced, present or enhanced at this step (according to the 5 M method)	(3) Origin or source of the hazard or danger	(4) Severity / Impact of effect	(5) Likelihood of occurrence	(6) Recommended level of requirement	(7) Justify decision for co (7)
Hot Water / Hot Vapour treatment	Harmful chemicals	Environmental Hazards Dirty or untreated water for Hor water/Vapour treatment	3	1	Recommendation	Hot water/vapour treatir facilities may not use potable water, some ma borehole
	Physical damage to fruit	Environmental Hazards • Heat buildup • Heat burn of fruits • Delayed before processing • Premature ripening	3	2	Major	Treated mango fruits sto for long in warm tempe may rot
	Pathogenic microorganisms such as E. coli, Salmonella	Environmental Hazards Dirty or untreated water used during the treatment Labour-related hazards Personnel used for handling hot water/vapour treatment Lack of compliance with GHP by staff Lack of control over health status Lack of hand-washing stations Materials hazards Unsanitized fruit contact surfaces – Poor maintenance of holding basins Hazards related to the raw material Contaminated water – Dirty washing facility Dangers related to working methods Not changing water frequently	3	2	Major	Poor hygiene practices personnel used Dirty brushed that are n maintained Use of untreated water Prolonged use of Hotwa vapour water Not changing water freq as required
	Chemical hazards	Hazards related to the raw material Residue of PPPs used to control fungi and bacterial diseases, Overuse of chemicals or use of wrong chemicals	3	2	Major	Possible overuse of chemicals during washi wrong chemicals used

Proposed appropriate control measures: SPS control plan

The following table lists the checks to be carried out on the production, processing and packaging process (self-checks): documentary checks, visual checks, measurements, product inspections, sampling for the analysis of biological or chemical contaminants.

The periodicity and nature of the verifications (technical aspects to be checked by the auditors and internal auditors), as well as the records to be made, are indicated in the table which can therefore be considered as the "SPS Control Plan" see Table 17- 18 below.

SPS PLAN FOR THE MAJOR risks identified in the Hazard Analysis

Table 17 – SPS Plan for the mango seedbed

S.N	Process Step	Nature and source of danger to be controlled	Recommended level of requirement	Recommended Control Measures	Checks and Registrations (Monitorin Self-check)
1	Scouting for pests and diseases	- Pathogens resulting into fruit rot Presence of pests in fruits	Major	-Scouting personnel not trained on pest diagnostics Scouting not done correctly to identify pests and diseases of concern	Visual checks Visual checks to ensure workers wash ha before scouting activities (workers perso hygiene) Documentary control: Checking the frequency of scouting and management of the pests e.g Scouting s Internal inspections Farmer to ensure the farm workers are w trained and that they are carrying out the scouting activities in the right manner Monitoring/scouting Use of traps to monitor key pests

S.N	Process Step	Nature and source of danger to be controlled	Recommended level of requirement	Recommended Control Measures	Checks and Registrations (Monitorin Self-check)
2	Crop protection (/ pest management	Pesticides residue > MRL Pesticide residues from use of unapproved products, wrong use of products or not observing pre-harvest interval	Major	Use of only approved or recommended pest control products. Observe pre-harvest interval Use products as per the instructions for use Training of personnel on proper application of PPPs and adherence of PPPs application guidelines Training on personnel on proper pruning practices and use of pruning guides (Orchard management practices) GAPs	Documentary control: Checking the list of authorized PPPs on t crop Checking the list at every use Verification of the recording of the pests management treatments carried out duri cultivation, record activities of crop prot treatment Internal inspections: Verification of the application of Crop pr treatment procedures
		Presence of pests on fruits	Major	- Even distribution of PPPs - Proper application of PPPs	Internal inspections: Supervision of use of the PPPS Documentary control: Checking the scouting record Verification of the recording of the crop management/ pest management includir protection products used
3	Pruning	Pests and diseases in mango trees	Major	Disinfecting and sanitizing of pruning materials Use of appropriate pruning technique and equipment	Internal inspections: Supervision of the use of appropriate pru equipment and sanitization before/after u
		Injury of the mango stems and branches due to use of inappropriate pruning technique & equipment	Minor	Use of appropriate tools that are well maintained e.g. in terms of sharpness	Documentary control: Confirmation and recording of type and concentration of disinfectants used Visual checks Visual checks to ensure pruning is done correctly

g:	Correction/Corrective Action
ands nal	Training of personnel on scouting and pest management and good hygiene practices
heet	Use of data to develop IPM and economic thresholds for pest management decisions (pest management decision guide)
ell	

S.N	Process Step	Nature and source of danger to be controlled	Recommended level of requirement	Recommended Control Measures	Checks and Registrations (Monitorin Self-check)
4	Harvesting	Chemical hazards such as pesticide residues MRL, oil, lubricants, fertilizers from dirty equipment and packaging/holding materials, oil and lubricant leaks from oil equipment	Major	Avoid application of pesticides near harvesting Observe recommended PHIs Use of clean recommended containers and crates for holding fruits Proper machine maintenance GAPs/ GHPs	Internal inspections Supervision to ensure equipment and containers used during harvesting meet minimum requirements Documentary control: Confirmation and recording of applicatio PPPs

Table 18 – SPS Plan for aggregation points/ packhouse

S/N	Process Step	Nature and source of danger to be controlled	Recommended level of requirement	Recommended Control Measures	Checks and Registrations (Monitorin Self-check)
1	Fruit reception, Weighing at packhouse	Pathogenic microorganisms such as E. coli, Salmonella from poor hygiene practices, poor handling practices and use of dirty crates/ containers/ and weighing equipment	Major	Providing toilets at packhouse for workers and hand washing stations Proper cleaning and disinfection of Containers used for holding fruits Proper sanitation of fruit contact surfaces GHP	Visual checks: Visual checks to ensure workers wash th hands Documentary control: Check that the batches of fruit are proper identified and segregated Internal inspections Farmer /aggregation points/ packhouse supervisor to ensure proper handling an hygiene practices
		Pesticide residues > MRL	Major	Training of personnel at reception on food safety non-compliances	Internal inspections Inspection of fruit at delivery to aggregat points/packhouse to ensure no visual pe residue

Registration Forms and Checklists

The following are factsheet, registration forms and checklists required for mango seddling nurseries ,orchards, aggregation centres, packhouses , they may be different depending on the value chain node and operations

Practical sheets (operating procedures)

- Safe use of pesticides
- General mango management plan: mango management chart
- Personal hygiene requirements at the mango orchard
- Mango quality defects
- Mango specifications chart
- Protocol for cleaning and disinfection of premises and equipment
- Hygiene rules at the packhouse
- Cold room temperature measurement protocol
- Waste and pollutants identification and disposal plan

Record sheets for traceability of operations

- Mango nursery stock specification propagation material record
- Fertilizer/ manure application record
- Fertilizer stock inventory
- Monitoring record for IPM pest traps
- Pest and disease monitoring record
- Pesticide application record
- Agronomic activities record (e.g. weeding, land preparation)
- Input's supplier audit checklist
- Daily harvest record
- Corporative/farmer group harvest record
- Daily temperature log
- Cleaning record
- Training record
- Visitor health declaration form
- Food safety & quality incidents record
- Product recall, withdrawal and reconciliation (mass balance) record
- Energy use monitoring record

Checklists

- Checklist for mango nursery phytosanitary inspection
- Shipping container dispatch checklist for mango
- Proposed packhouse fresh mango quality checklist
- Proposed packhouse fresh mango phytosanitary inspection checklist

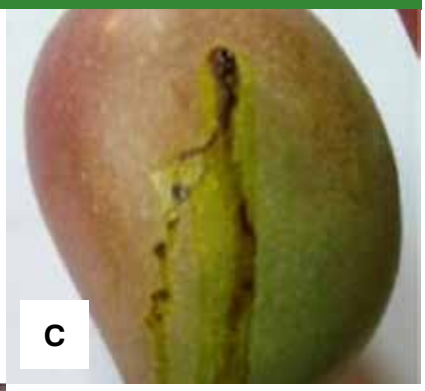
5. ANNEXES

5.1. Mango Fruit Photo guides

Mango Fruit Fly











A. Adult Oriental fruit fly (Bactrocera dorsalis). *©Robert Copeland, ICIPE*

B. Mango fruit fly (Ceratitis cosyra). © *Farmtrack Ltd, Kenya*

C. Sap exudation from mango fruit damaged by the fruit fly. *©Ngugi, CN, KALRO*

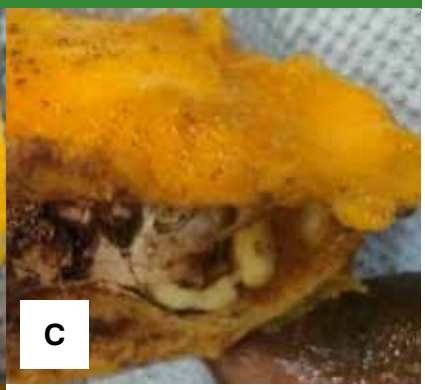
D.Mango fruit fly larvae and fruit rot. © *Ngugi, CN, KALRO*

E. Extensive fruit rot caused by mango fruit rot larvae. *©Hellen Heya, KEPHIS*

Mango Seed weevil











A. An egg-laying mark of mango seed weevil. *©A. M. Varela, ICIPE*

B. Entry point on the seed stone. © *Ngugi CN, KALRO*

C. Tunneling and frass on mango seed. *Ngugi CN, KALRO*

D.Weevil grab inside mango seed. © *CABI Plantwise*

E. Extensive fruit rot caused by mango fruit rot larvae. *©MaryLucy Oronje, CABI*

5.2. Fruitfly sample scouting record

Copyright for the sole use of XXX	Document Title	Pest Monitoring	
	SCOUTING RECORD	Form No:	XXX/REC/06
		Issue No:	A
		Revision:	1
		Page	1 of 1

BLOCK NO……. SIZE ……Ha NO. OF TREES……

PLANTING DATE ……..….CROP/ VARIETY ……..……CROP AGE …… week(s)

THRESHOLD LEVELS

Pest	Fruit Fly	Mango seed weevil
Threshold levels	X	

Number of Plants affected (out of 10) per each scouting station

Pest/Beneficial Insects	1	2	3	4	5	6	7	8	9	10	Av	Recommendations; Spray No Spray Trade Name: LAMDEX……
	0	1	0	0	3	1	1	0	0	0	0.6	Active ingredient: Lamdacyhluthrine……..
												Pesticide Dosage/Rate …0.5l……
												Quantity of pesticide ……..
												Amount of water: ……...
												Technique/Mode: ……...
												Equipment used/ serial: ……
												Pressure: …… ……
												Equipment Operator: ……
												Date of Application: ……..
												Recommended by; …… Sign …… Date; ……

Beneficial insects found ……

Signed by Scout: …… Date: ……

5.3. Mango Seed Weevil sample of scouting record

Copyright for the sole use of CABI	Document Title	Pest Monitoring	
	SCOUTING RECORD	Form No:	CABI/REC/06
		Issue No:	A
		Revision:	1
		Page	1 of 1

BLOCK NO……. SIZE ……Ha NO.OF TREES……PLANTING DATE ……..….CROP/ VARIETY ……..……CROP AGE …… week(s)

THRESHOLD LEVELS

Pest	Fruit Fly	Mango seed weevil
Threshold levels		

Number of Plants affected (out of 10) per each scouting station

Pest/Beneficial Insects	1	2	3	4	5	6	7	8	9	10	Average	Recommendations; Spray No Spray Trade Name: ……
												Active ingredient: ……..
												Pesticide Dosage/Rate ……
												Quantity of pesticide ……..
												Amount of water: ……...
												Technique/Mode: ……...
												Equipment used/ serial: ……
												Pressure: …… ……
												Equipment Operator: ……
												Date of Application: ……..
												Recommended by; …… Sign …… Date; ……

Beneficial insects found ……

Signed by Scout: …… Date: ……

5.4. Pesticide application recording sheet

Sheet No.…

PESTICIDE APPLICATION RECORD SHEET

Farm Name_____ Location_____

Block No_____ Area (Ha/Acres) _____ Crop_____

Variety _____ Planting Date _____

Summary of Pesticide Application

Date of Application	Trade Name of Pesticide	Active Ingredient	Rate per Hectare /Acre	Quantity Applied	Mode of Application	Re-Entry Interval (REI)	Pre-Harvest Interval (PHI)	Machinery Used	Operator's Name	Advised by Name/ Sign

5.5. Sample Traceability Policy

Company: Name/Organization
Standard Reference: GLOBALG.A.P. IFA (latest version), KEPHIS requirements, Food Safety Management principles

(Company/Organization name) is committed to establishing, implementing, and maintaining an effective traceability system that ensures all agricultural products handled by the company can be traced **one step back (input/supplier/field)** and **one step forward (customer/market)** at all times.

The company ensures that:

- All produce is uniquely identified from field/farmer through harvest, packing, storage, and dispatch
- Records are accurate, complete, legible, and maintained for the required retention period
- Traceability supports rapid product withdrawal and recall where necessary
- The traceability system complies with GLOBALG.A.P., KEPHIS, and applicable statutory and customer requirements

Management commits adequate resources, training, and supervision to ensure effective implementation of this policy.

1 OBJECTIVES

- To enable full traceability of all products handled by Nurtured Produce Ltd.
- To link each product to its origin (farm, plot, producer, inputs used).
- To ensure effective product recall and withdrawal if a food safety risk is identified.
- To meet certification, regulatory, and customer requirements.

2 SCOPE

This procedure applies to:

- All company-owned farms and contracted/outgrower farmers
- All registered crops (e.g. fruits and vegetables)
- All stages: production, harvesting, packing, storage, and dispatch

3 DEFINITIONS

- **Traceability:** Ability to follow the movement of a product through specified stages of production, processing, and distribution.
- **Lot/Batch:** A defined quantity of produce harvested or packed under similar conditions.
- **Recall:** Removal of unsafe product from the market.
- **Withdrawal:** Removal of product before it reaches the consumer.

4 ROLES AND RESPONSIBILITIES

Managing Director

- Approves the traceability policy and procedure.
- Ensures adequate resources are provided.

Quality / Food Safety Manager

- Implements and maintains the traceability system.
- Conducts traceability tests and mock recalls at least once per year.
- Ensures compliance with GLOBALG.A.P. and KEPHIS requirements.

Farm Manager / Outgrower Coordinator

- Ensures correct farm, field, and farmer identification.
- Maintains production and input records.

Packing House Supervisor

- Ensures correct lot coding during packing.
- Maintains packing and dispatch records.

Storekeeper

- Maintains records for packaging materials and inputs.

5 TRACEABILITY PROCEDURE

Farm and Farmer Identification

- Each farm and outgrower is assigned a **unique farm/farmer code**.
- Each plot/field is assigned a **unique plot code**.
- Farm maps are maintained and updated.

Production Records

The following records are maintained per farm/plot:

- Seed/planting material records
- Agrochemical application records
- Fertilizer and soil amendment records
- Irrigation and water source records
- Harvest records

All records reference the **farm code, plot code, crop, and date**.

Harvest Identification

- Produce is harvested in identifiable lots.
- Each harvest lot is labelled with:
  - Farm/farmer code
  - Plot code
  - Crop
  - Harvest date
  - Harvest lot number

Packing and Lot Coding

Each packed product is assigned a **unique lot/batch code**.

- Lot code links to:
  - Harvest lot
  - Packing date
  - Packing line (where applicable)
  - Product type and grade

Storage and Handling

- Products are stored in designated, labelled areas.
- Mixing of lots is avoided unless records clearly document the combination.

Dispatch and Sales Records

- Dispatch records include:
- Product name

- Lot/batch number
- Quantity dispatched
- Date of dispatch
- Customer name and destination

This ensures one-step-forward traceability.

6 PRODUCT RECALL AND WITHDRAWAL

- The company maintains a documented **Recall and Withdrawal Procedure**.
- Traceability records allow identification of affected lots within **4 hours**.
- Mock recall exercises are conducted at least **once per year** and records maintained.

7 RECORD KEEPING AND RETENTION

- All traceability records are kept for a minimum of **2 years** or as required by applicable standards and customers.
- Records may be maintained in hard copy or electronic format.

5.6. Mango Maturity Testing Standard Operating Procedure (SoP)

Company: .....
SOP No.: .....
Effective Date: _____
Revision No.: .....
Prepared by: _____
Approved by: _____

1 PURPOSE

To define standardized procedures for determining mango maturity prior to harvest to ensure optimal eating quality, shelf life, food safety, and compliance with **KEPHIS** and **GLOBALG.A.P.** requirements.

2 SCOPE

This SOP applies to:

- All mango production blocks
- Farm supervisors and field staff
- Quality assurance (QA) team
- Packhouse intake operations

3 RESPONSIBILITIES

Farm Manager

- Ensure maturity testing is conducted before harvest authorization
- Verify records are completed and filed

Field Supervisor

- Conduct maturity tests as per this SOP
- Supervise sampling and documentation

Quality Assurance Officer

- Review and approve maturity results
- Retain records for audit purposes

Harvest Team

- Harvest only fruit approved as mature

4 DEFINITIONS

- **Physiological Maturity**: Stage when mango has completed growth and can ripen properly after harvest
- **Dry Matter (DM)**: Percentage of solid content in mango flesh
- **TSS (Brix)**: Measure of soluble sugars in fruit juice

5 MATERIALS & EQUIPMENT

- Sharp stainless-steel knife
- Weighing scale
- Drying oven / portable dry matter tester
- Refractometer (if applicable)
- Sampling bags or trays
- Maturity testing record form
- PPE (gloves, apron)

6 MATURITY INDICATORS

Days from Flowering

- Mangoes reach maturity **90–120 days after full flowering** (variety dependent)
- Flowering dates must be recorded per block

Fruit Size and Shape

- Fruit must reach full varietal size
- Shoulders raised above the pedicel
- Fruit appears plump and well-filled

Skin Colour

- Change from dark green to light green
- Some varieties show yellowing or red blush
- Colour alone must NOT be used as the sole indicator

Flesh Colour (Cut Test)

- Mature fruit shows **yellow to orange flesh**
- Immature fruit shows whitish or pale flesh

Dry Matter Content (Preferred Method)

- Minimum acceptable dry matter: **14–16%** (variety dependent)

Calculation:
Dry Matter (%) = (Dry weight ÷ Fresh weight) × 100

Latex Flow Test

- Mature fruit produces milky latex that flows freely
- Immature fruit shows watery or excessive latex

Total Soluble Solids (Optional)

- Harvest maturity: **7–9° Brix**
- Used mainly for monitoring ripening

7 SAMPLING PROCEDURE

- Select **5–10 fruits per block**
- Sample from:
  - Upper and lower canopy
  - Inner and outer tree sections
- Avoid damaged or diseased fruit
- Label samples with block and date

8 TESTING PROCEDURE

Field Assessment

- Check fruit size, shape, skin colour, and latex flow

Cut Test

- Slice fruit longitudinally
- Observe flesh colour and firmness

Dry Matter Testing

1. Cut a flesh sample (no skin)
2. Weigh fresh sample
3. Dry at 65–70°C until constant weight
4. Weigh dry sample
5. Calculate dry matter percentage

9 ACCEPTANCE CRITERIA

- Fruit meeting **minimum dry matter and visual maturity** shall be approved for harvest
- Fruit below maturity standards shall be rejected and re-evaluated later

10 HARVEST AUTHORIZATION

- Harvest shall only proceed after:
  - Maturity results are satisfactory
  - Harvest Authorization Form is signed by QA or Farm Manager

11 RECORD KEEPING

The following records shall be maintained:

- Flowering records
- Mango maturity testing log
- Dry matter test results
- Harvest authorization forms

Records shall be retained for **at least 2 years** or as per customer and regulatory requirements.

12 NON-CONFORMITY & CORRECTIVE ACTION

Immature fruit detected → delay harvest

Mixed maturity fruit → segregate and retrain harvest team

Repeated failures → review maturity testing procedures

13 HEALTH, SAFETY & HYGIENE

- Use clean and sanitized tools
- Wear PPE during testing
- Dispose of cut fruit hygienically

5.7. Post-Harvest Packaging and Packhouse Procedures & Policies

This document should include the following:

A: **Organization/Company Name**
B: **Applicable Standards:** GLOBALG.A.P., KEPHIS, Codex Alimentarius
C: **Effective Date:**
D: **Review Date:**

1 PURPOSE

To ensure that all fresh produce handled at the packhouse is hygienically managed, safely packed, properly labeled, and traceable, while maintaining quality and complying with GLOBALG.A.P., KEPHIS, and food safety requirements.

2 SCOPE

This policy applies to all post-harvest activities including reception, sorting, grading, packing, storage, and dispatch of fresh fruits and vegetables at the packhouse.

3 RESPONSIBILITIES

- **Packhouse Manager:** Overall compliance, supervision, and documentation.
- **Quality/Food Safety Officer:** Monitoring hygiene, quality checks, records, and corrective actions.
- **Supervisors:** Daily implementation of procedures.
- **Packhouse Workers:** Compliance with hygiene and handling procedures.
- **Maintenance Officer:** Equipment cleanliness and maintenance.

4 PACKHOUSE HYGIENE POLICY

- The packhouse shall be kept clean, pest-free, and well maintained.
- Only authorized personnel may access the packhouse.
- Eating, smoking, chewing gum, or drinking is strictly prohibited inside processing areas.
- Adequate handwashing facilities with soap, clean water, and sanitizers shall be provided.

5 PERSONNEL HYGIENE PROCEDURE

- All workers must undergo medical screening annually.
- Workers must wear clean protective clothing (coats, hairnets, gloves, gumboots).
- Hands must be washed before starting work, after breaks, and after toilet use.
- Any staff with symptoms of illness must report immediately and be excluded from handling produce.

4 PRODUCE RECEPTION PROCEDURE

- Produce shall be harvested following approved harvesting SOPs.
- Incoming produce must be inspected for:
  - Physical damage
  - Contamination
  - Maturity and quality specifications
- Accepted produce shall be recorded in the **Produce Reception Register**.
- Rejected produce shall be clearly identified and disposed of appropriately.

5 POST-HARVEST HANDLING PROCEDURE

Sorting and Grading

- Produce shall be sorted on clean, food-grade surfaces.
- Damaged, diseased, or contaminated produce shall be removed.
- Grading shall be based on size, weight, color, and market specifications.

Washing (Where Applicable)

- Only potable water shall be used.
- Water quality shall be monitored and recorded.
- Approved sanitizers may be used according to manufacturer instructions.

8 PACKAGING PROCEDURE

- Only clean, food-grade packaging materials shall be used.
- Packaging materials must be stored off the floor in a clean, dry area.
- Each package shall be labeled with:
  - Producer name/code
  - Product name
  - Batch/lot number
  - Packing date
  - Destination market
- Overfilling or underfilling of packages is not allowed.

9 TRACEABILITY PROCEDURE

- Each consignment must be traceable one step forward and one step back.
- Lot/batch numbers shall link produce to:
  - Farmer/supplier
  - Harvest date
  - Packing date
- Records must be retained for a minimum of **2 years** or as required by the standard

10 STORAGE PROCEDURE

- Storage areas must be clean, ventilated, and temperature-controlled where required.
- Produce shall be stored off the floor and away from walls.
- First-In-First-Out (FIFO) principle shall be applied.
- Temperature and humidity shall be monitored and recorded daily.

11 TRANSPORTATION & DISPATCH PROCEDURE

- Vehicles must be clean, covered, and dedicated for food use.
- Produce must be protected from contamination and physical damage during transport.
- Dispatch records shall include:
  - Product description
  - Quantity
  - Batch/lot number
  - Customer/destination

12 WASTE MANAGEMENT POLICY

- Organic waste shall be collected in labeled bins and disposed of daily.
- Packaging and inorganic waste shall be segregated and disposed of through licensed waste handlers.
- Waste areas shall be kept clean and pest-free.

13 CLEANING & SANITATION PROCEDURE

- Cleaning schedules shall be displayed and followed.
- Approved detergents and sanitizers shall be used.
- Cleaning records must be completed after each activity.

⑭ PEST CONTROL PROCEDURE

- A pest control program shall be implemented by a licensed provider.
- Bait stations and traps shall be monitored and recorded.
- Chemicals shall never be applied when produce is exposed.

⑮ NON-CONFORMITY & CORRECTIVE ACTIONS

- All deviations shall be recorded in a **Non-Conformance Register**.
- Root cause analysis shall be conducted.
- Corrective and preventive actions shall be documented and verified.

⑯ TRAINING POLICY

- All packhouse staff shall receive induction and refresher training on:
  - Hygiene and food safety
  - Post-harvest handling
  - Emergency procedures
- Training records shall be maintained.

⑰ DOCUMENT CONTROL & REVIEW

- This document shall be reviewed annually or when changes occur.
- Controlled copies shall be issued and obsolete documents removed.

Approved By: _____

Position: _____

Signature & Date: _____

5.8. Vapour heat treatment (VHT) facility SoP

Department: Phytosanitary & Biosecurity Services

Revision No.: 00 **Issue No.**: 01

UK International Development

SOP Ref: SOP/KEPHIS/VHT/01

Effective Date: _____

Approved by: _____

1 Purpose

To provide standardized procedures for the structural performance, operation, verification, phytosanitary security, documentation, and training requirements for Vapour Heat Treatment (VHT) facilities to ensure effective phytosanitary treatment of horticultural produce (e.g. mangoes) in compliance with KEPHIS and importing country requirements.

2 Scope

This SOP applies to all VHT facilities, operators, exporters, and KEPHIS inspectors involved in the operation, monitoring, verification, and certification of Vapour Heat Treatment processes for export commodities.

3 References

- KEPHIS Act No. 54 of 2012
- Plant Protection Act (CAP 324)
- Export Act (CAP 319)
- International Plant Protection Convention (IPPC)
- ISPM No. 1 – Phytosanitary principles
- ISPM No. 5 – Glossary of phytosanitary terms
- ISPM No. 28 – Phytosanitary treatments for regulated pests
- ISO 9001:2015

4 Definitions and Abbreviations

- **VHT:** Vapour Heat Treatment
- **KEPHIS:** Kenya Plant Health Inspectorate Service
- **NPPO:** National Plant Protection Organization
- **Sensor:** Temperature or humidity probe used during treatment
- **Data Logger:** Computer-controlled device for continuous recording of treatment parameters

5 Responsibilities

VHT Facility Management

- Ensure compliance with this SOP and all regulatory requirements.
- Maintain infrastructure, equipment, and records.

VHT Operators

- Conduct treatments according to approved procedures.
- Ensure correct sensor placement and data recording.

KEPHIS Inspectors

- Verify facility compliance.
- Audit records and witness treatments where required.

6 Structural Performance Requirements

Treatment Chamber (Critical)

The treatment chamber shall:

- Reach and maintain prescribed temperatures and humidity levels.
- Be clean, pest free, and structurally sound.
- Prevent pest entry during treatment.

Data Logger and Recording Equipment (Critical)

- Computer-controlled and secure from tampering.
- Tamper-evident design.
- Capable of continuous data recording.
- Record all sensors at least every 5 minutes.
- Identify each sensor, its position, time, temperature, humidity, and facility name.
- Be unaffected by environmental conditions such as vibration.

Temperature Sensors (Critical)

- Accuracy of ±0.3°C within 37°C–52°C range.
- Resolution of 0.1°C.
- Unique identification for each sensor.

Post-Treatment Area (Critical)

- All openings sealed or covered with mesh ≤1.6 mm.
- Clean and pest free at all times.

Entry and Exit Points (Major)

- Systems in place to reduce pest entry and exit (airlocks, air curtains, physical barriers, or positive air pressure).

(7) Treatment Procedures

Number of Sensors (Critical)

- Sensor numbers shall be determined based on chamber size and thermal mapping results.

Calibration of Sensors (Critical)

- Sensors calibrated by an approved authority.
- Calibration certificates available.
- Sensors must read within ±0.3°C at 46°C.
- Calibration conducted at the start of the season and monthly during treatment season.

Placement of Temperature Sensors (Critical)

- Required number of sensors used per chamber.
- Pre-loading checks conducted using the largest/heaviest fruit.
- Sensor placement plan verified before each treatment.
- Diagram of correct sensor placement displayed and accessible.
- Sensors securely fixed to prevent dislodgement.

Sealing of Treatment Chamber (Major)

- Chambers sealed prior to treatment.
- Seal numbers recorded.
- Written procedure in place for dealing with tampered or broken seals.

Treatment Process (Critical)

- Treatment parameters maintained at 46–48°C for mango fruits.
- Relative humidity maintained as prescribed.
- Total heat vapour exposure not exceeding 4 hours.
- Continuous monitoring throughout treatment.

8 Verification of Treatment

Sensor Readings (Critical)

- Treatment results determined through data analysis.
- Treatment data submitted to KEPHIS for certification.

Treatment Failure (Critical)

A treatment is deemed to have failed if:

- Chamber is unlocked or seals tampered with.
- Sensors incorrectly placed.
- Prescribed temperature/time not achieved.
- Required humidity not maintained.

9 Phytosanitary Security Measures

Segregation of Produce (Critical)

- Treated produce clearly identified.
- Segregated from untreated produce.

Traceability (Major)

- Traceability to packhouse.
- Traceability to grower where required.

Post-Treatment Security (Critical)

- Post-treatment area kept clean and pest free.
- Measures in place to prevent infestation or re-infestation.

10 Documentation and Records

Documented Systems (Critical)

Documented and implemented procedures for:

- Treatment operations.
- Chamber security and seal management.
- Loading and sensor placement.
- Goods handling and movement.
- Equipment calibration.
- Treatment failures.

Records (Critical)

Maintain records for a minimum of two (2) years, including:

- Treatment dates and facility name.
- Sensor calibration results.

- Sensor placement records.
- Chamber sealing details.
- Treatment parameters (time, temperature, humidity).
- Receivals, storage, and dispatch records.
- Maintenance, internal verification, and failed treatments.

11 Training Records (Major)

Training records shall be maintained for staff involved in:

- Sensor placement.
- Handling treated produce.
- Analysis of treatment data.
- Use of monitoring software.

Training records must include:

- Training content.
- Date of training.
- Trainee name.
- Evidence of competence.

Internal training materials shall be made available upon request.

12 Revision History

Revision No.	Issue No.	Date	Reason	Approved By
00	01		New SOP	

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