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# HARVEST, CLASSIFICATION, TRANSPORTATION AND PACKAGING OF EXPORT TYPE MANGOES

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## HARVEST, CLASSIFICATION, TRANSPORTATION, AND PACKAGING OF EXPORT TYPE MANGOES

GUINÉ-BISSAU  
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## I. INTRODUCTION

This work gave an emphasis on the pre- and post-harvest phases of mangoes for the export market, with the objective of improving the quality and expanding the amounts of exportable fruits from plantations in Guinea-Bissau.

During this period, I worked with a group of producers and potential exporters, discussing and practicing those cultivation procedures which every plantation needs in order to produce and offer fruits which reach harvest time in good health and are attractive to the market. There were also discussions and training on how to harvest, handle, treat, and pack these fruits so that they reach final consumers in the best condition, regarding appearance, color, taste and flavor.

I believe that the group I worked with is aware of those agricultural and commercial activities necessary in order to improve and propel the cultivation of mangoes in Guinea-Bissau.

The edapho-climatic conditions of the country were analysed as well as the profile of the producer and the exporter. The conclusion was that Papaya (*Carica Papaya*), 'Gália' Melon (*Cucumis Melo*), Okra (*Abelmoschus*), Bell Pepper (*Capsicum Sinense*), and String Beans (*Phaseolus Vulgaris*) are options which can offer Guinea-Bissau the best opportunity to enter the market during certain times of the year.

## II. ACTIVITIES

- a) Visits to 'pontas' (farms) in order to come up with a projection for the harvest of 1995 according to varieties, period of picking, and a general analysis of the plantations.

The 1995 harvest will be far below that expected due to the fact that the 'ponteiros' did not carry out the pre-harvest cultivation care as recommended. The plantations, in general, show the presence of diseases and are attacked badly by insects (trips, selenothrips rubrocinctus and cochonilhas, aulacaspis tubercularis), which declassify the product in the export market.

### ESTIMATE OF PRODUCTION

Variety	Volume (tons)
1. Smith	5
2. Zill	10
3. Kent	35
4. Keitt	30
5. Palmer	12
6. Ruby	1
7. Tommy Atkins	2
	<hr/> 95

95 tons divided by 4 kg per box equals 23,750 boxes.

The estimate is only for fruit of export quality. I believe that production could double if those fruits which lack quality, mainly due to the absence of color, were added. Therefore, there is a need to make the producer aware of this problem so that he does the trimming for aeration.

b) Selection of producers and potential exporters interested in the exporting program.

A group of producers and potential exporters interested in working with mangoes was selected. They received training on how to manage their plantations and to make a competitive product available to the international market.

c) Pre-harvest practices

- c.1) Trimming for aeration - aims at clearing the top of the trees in order to improve the amount of sunlight on the fruits, making them more colorful.
- c.2) Combat of white-ants, or termites - This plague is spreading rapidly in the country and must be controlled because, besides occupying large areas with its mounds, it attacks the trees, destroying their root systems and trunks, and even killing them. The pest control is done with the use of pesticides such as Gastoxin (phosphate), Carbaril (7.5%) (carbonate), etc.
- c.3) N-P-K fertilization plus Calcium - The fertilization should be done at the beginning of the rainy season and always at the projection of the tree. The purpose is to return those nutrients which the fruits took in the previous season. We call attention to calcium because it contributes to the internal firmness of the fruits besides giving more consistency to the pulp.
- c.4) Cleaning - Always maintain the plantation clean, with no competition with weeds. We suggest the cultivation of intercalate cultures such as: maize (ZEA MAYS), beans (PHASEOLUS VULGARIS), peanuts (ARACHIS HYPOGAEA).
- c.5) Flowering induction - This procedure aims at the standardization of flowering and should be done when the trees present characteristic signs such as swollen buds with no new vegetation, early manifestation of hydric stress - this is the time to apply potassium nitrate.
- c.6) Flowering - When the trees are all covered with flowers, monitor them for TRIPS (Selenothrips rubrocinctus) because this disease damages the young fruits. In case it is present, pulverize with systemic pesticides (Dimethoate - 0.2%).
- c.7) Cleaning of Fruits - When fruits are 5cm in diameter, similar to the size of a tennis ball, they should be cleaned, with the removal of the aborted fruits, rachis, branches and leaves which may, eventually, shade or damage the fruits. The malformed racemes which did not develop into fruits should be removed and burned.
- c.8) Control of plagues and diseases - There should be close attention paid to the weather conditions because in case it rains during the flowering and/or maturation stages, it is necessary to pulverize the trees against Antracnosis (Colletotrichum Gloeosporioides).

During the dry period, the flowering period, oidium (*Oidium Mangiferae*) may appear and must be controlled because it causes flowers and small fruits to fall.

Yellow ants or termites, (*Coanitermes* SP and *Syntermes* SP) cause great damage to plantations. Use gas and powder pesticides to combat them.

Thrips (*Selenothrips Rubrocinctus*) and Cochineal (*Aulacaspis Tubercularis*) are insects that suck and scrape the fruits, disqualifying them for exportation. Prevention is done with systemic pesticides and mineral oil.

### III. CONCLUSIONS

The pre- and post-harvest works were well assimilated by all participants. I also believe that this group is aware of those agricultural and commercial activities necessary to improve and propel the mango production of Guinea-Bissau.

I also concluded that the edapho-climatic conditions and the readiness of available labor places the country in a favorable condition to work with other cultures that are suggested here.

The major difficulties to export are:

- a) absence of export credit;
- b) the great number of varieties of minor acceptance in the European market;
- c) late production

As for the course itself, there were 28 participants. There was great motivation and extra practical sessions with all the activities were carried out in a plantation and also post-harvest activities and all participants were evaluated individually with a good result.

### IV. RECOMMENDATIONS

- a) Techno-agronomic assistance

The Guinean producer and the potential exporter need technical and agronomic assistance to orient and alert them about how to carry out of those activities which the culture requires, at the right time, such as: substitution of the cover, selection of the varieties, and pre- and post-harvest procedures.

The spreading of the technology should continue periodically with training and sensibilization of the producer/exporter to constantly improve the quality of the product.

I consider of great importance a technical orientation during the next mango season as the objective is to make the production of Guinea-Bissau competitive in the European market.

Courses and/or seminars about the alternate cultures are also necessary with the objective of reaching a good production of export-type quality product.

b) Techno-commercial assistance

It is necessary to orient the Guinean producer/exporter about the procedure for sending their product to the foreign market because they do not possess experience of exportation. Besides courses and/or seminars, assistance is necessary at the beginning of the season.

c) Alternate Cultures

There is a need to test other cultures in order to take advantage of the eventual windows in the market and the agricultural potential of Guinea-Bissau. I recommend, as an alternative, the cultivation of Papaya, 'Galia' Melon, Okra, String Beans, and Bell Pepper. It should be kept in mind that these alternatives also need technical orientation.

d) Micro-industry for the processing of mango

It is necessary to foster the use of the leftover production of mango, cashew, papaya, etc., as sweets, preserves, juices, and dehydrated and frozen products by micro entrepreneurs. There is a good market for these industrialized products. This is also a way of preventing the waste of those fruits not classified for export.

# APPENDIX A

## PRE-HARVEST PROCEDURES

### SEQUENCE OF SUGGESTED ACTIVITIES TO BE CARRIED OUT IN THE MANGO PLANTATIONS OF GUINÉ-BISSAU AIMING AT THE IMPROVEMENT OF THE FRUITS FOR THE EXPORT MARKET

1. After the harvest, which shall finish on the second half of the month of July:

a) **Trimming for aeration:** Open up the treetop of all trees by cutting off part of the branches and sections in the center in order to facilitate the penetration of sunlight. This will result in an improvement on the coloration of the fruits and a lower incidence of plagues and diseases.

**Period: July and August**

b) **Substitution of treetops:** Cut off those trees whose tops will be substituted. This cut shall be done at a 45° angle, with a height of 80cm, and brushed with a solution made with 10 lt. of water, 2 kg of lime, and 1kg of copper sulphate.

**Period: August**

c) **Combat of Termites:**

- **in mounds:** use one tablet of gas insecticide. Dig 5 - 10 holes, 30 cm deep, around the mound. apply the product in each one of the holes and cover them.

Phosphine - one tablet per hole.

- **on the soil:** apply insecticide (powder Carbaril 7.5), 100g/m<sup>2</sup> on top of nest and mix it with a shovel or rake, depending on size.

- **on mango trees:** 1) Apply insecticides on the soil around the tree, from the trunk to the projection of the cover since termites attack the roots; 2) destroy the nest of the termites and brush the trunk with a solution of insecticides plus the solution described above (in b.)

These procedures must be repeated every three months until the total extermination of this plague is achieved.

**Period: August and September**

d) **Fertilization:** The use of calcium fertilizers would be advisable in August; the other fertilizers should be used during the flowering stage.

<u>Product</u>	<u>Amount per Tree</u>
Dry Manure	20 lt.
Nitrogen (N)	1.0 kg.
Phosphorus (P205)	0.5 kg.
Potassium (K20)	1.0 kg.
Calcium (CaO)	1.0 kg.

**Note:** In case it is possible to utilize only one of these products, apply the Calcium.

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The fertilization is done at the projection of the treetop in 15 cm deep furrows. Spread the fertilizer and cover.

**Period: September**

e) **Cleaning:** Always maintain the plantation clean; brushwood competes for water, light, nutrients, and favors the infestation of plagues and diseases.

**Period: whenever necessary.**

## II. FLOWERING INDUCTION

Let the rainy season finish; then closely follow the evolution of the trees. The right moment for the induction is when the trees are well developed, that is, with no new leaves on the branches and when these branches start demanding water. Apply the solution below four (4) times at five day intervals, and water the trees well. Portable or mechanized sprayers with good pressure can be used.

**Solution:**

- 1st. - Potassium Nitrate (2%)
- 2nd. - Potassium Nitrate (2%)
- 3rd. - Potassium Nitrate (2%)
- 4th. - Calcium Nitrate (2%)

Citowetti or Extravon (0.03%) should be also used in all sprays (adhesive detergents). On the fourth spraying, a systemic insecticide should be added (Dimethoate - 0.2%) for the combat of 'thrips' (Thrips Tabaci, Selenco Thrips, Rubrocinctus).

**Period: November**

## III. FLOWERING

As soon as the first flower buds show up, the weekly irrigation should be started (that is, for those who can perform them).

When the trees are all covered with flowers, cover them with a systemic insecticide to combat 'thrips', if possible, together with a foliage fertilizer with calcium and barium such as Calcium Nutrisan- 0.3%. CaB2 - 0.3%.

## IV. CLEANING OF FRUITS

When fruits are 5cm in diameter, clean all the surrounding area in order to improve coloring and avoid damage:

- Remove the aborted fruits which did not fall;
- Remove all raquis with no fruits;
- Remove all branches and leaves which, eventually, shade the fruits too much;
- Remove those leaves which are damaging the fruits.

The malformed racemes which did not grow into fruits should be removed and burned at the time of this trimming.

## V. HARVEST

Perform the harvest utilizing the criteria already mentioned. This should probably happen in April and May if the induction is done at the correct time.

## VI. GRAFTING FOR SUBSTITUTION OF TREETOPS

The best time to carry out the grafting is during the rainy season due to a greater availability of water in the soil when, consequently, the grafts will take better. We call attention to the use of those varieties which have more acceptance in the international market, such as Tommy Atkins, Van Dyke, Haden - 2H.

Grafting should be done per tree cut, using selected grafts distributed evenly around the trunk. When the grafts reach 40cm, they should be trimmed, allowing them to grow again and produce three new branches from different points turning outwards. These will again be trimmed later to leave two open branches to develop to 40cm when they will, again, be trimmed to leave three branches each, always growing from different points and turning outwards.

This same system of conducting the trimming should be followed by those producers who are planting new trees or already have them at the stage of conduction and first trimming of formation.

**VII.** Whenever new trees are planted, they should be isolated from cashew plantations since these trees belong to the same family and, therefore, are subject to the same plagues and diseases.

**VIII.** Those producers in need of grafts should go to ANAG, which is responsible for supplying the producers with the best material of export quality.

ANAG should develop a campaign to orient producers about the losses resulting from termites and how to combat them. There is a great infestation of termites in all agricultural and non-agricultural areas. This is a worrying situation because this plague multiplies rapidly, occupying vast areas, besides attacking trees and even killing them.

## IX. COCHONEAL: (Aleurothixus Floccosus; Coccus Viridis; Aulacaspis Tubercularis)

With trimming for aeration, the cochoneal will tend to disappear; if this does not happen, apply systemic insecticides (Dimethoate - 0.2% and/or vegetal oil - 0.03%).

## X. DISEASES

In case it rains during the Flowering and Maturation stages, it is adequate to protect the trees against Antracnosis (Colletotrichum Gloeosporioides). During the flowering stage it causes the falling of the flowers and during the maturation of fruits. This results in rotting and dark spots on the fruits and leads to the lowering of their commercial quality and shelf life.

Products used:	Technical Name	Commercial Name
	Mancozeb - 0.4%	Manzate
	Benomyl - 0.1%	Benlate
	Clorotalonil - 0.4%	Daconil
	Methilic Tiophanate - 0.1%	Cercobin

**OIDIUM (Oidium Magiferae):** Eventually, a whitish layer similar to talcum powder may occur on the flowers and small fruits. They are signs of the presence of oidium which causes the falling of the flowers and small fruits.

Protect with: Sulphur - 0.3%, or Triadimefon - 0.2%

## APPENDIX B

### HARVEST, CLASSIFICATION, PACKAGING, AND TRANSPORTATION OF

#### MANGO FOR EXPORT

Harvest is one of the links of the production process which, if done with no planning and care, might be expected to cause the loss of good profits for a year.

When considering exportation, one must work with determination, seriously considering all the production factors; otherwise there will be no success, and, perhaps, a loss of credibility. If a producer implements a culture according to the edaphoclimatic conditions and with the adequate cultural and phitosanitary care, all which take an average of three years, this producer should not send to the market a low quality product because of a bad harvest, jeopardizing all the previous work.

Some studies on the various marketing systems have pointed out a 35% to 50% loss of fruits from the farm gate to the final consumer. These losses are the result of poor care during the harvest, transportation, classification, packaging, transportation, and storage stages. Therefore, producers must pay special care to this stage of production in order to guarantee success.

#### 1. TIME OF HARVEST

Edaphoclimatic factors, cultural and phitosanitary care, means of transportation, and final destination of the fruits are the factors which will define the time of the harvest.

a) Young                      Adolescent                      Climacteric                      Senescence  
0 \_\_\_\_\_ 21 \_\_\_\_\_ 51 \_\_\_\_\_ 120 \_\_\_\_\_ days

1. **Young** - High percentage of water; rapid rate of growth; high development rate of growth; low carbon/nitrogen relationship.
2. **Adolescent** - Distinct aroma; maximum stage of growth; high development rate and carbon/nitrogen relationship.
3. **Climacteric** - Physiologic maturation; Brix degree measure - 12 to 15; typical flavor, color, and taste; best quality; best conservation
4. **Senescence** - Taste and flavor begin to alter; soft texture; the skin loses its shine.

Various parameters have been suggested during the climacteric stage in order to determine the maturation of the mango, such as the physical and external appearance (chemical composition and texture) close to harvest time. These indices vary considerably, depending on the variety and should be used with care.

#### a.1 Physical Appearance

- Maturation Stage

Growth of top bulging of fruit  
Coloration of the fruit  
Texture of the pulp of the fruit

Based on these factors, four stages of maturation can be defined:

1. The top bulges are in line with the point of insertion of the peduncle and the color of the skin is olive green
2. The top bulges are a little higher than the line of insertion of the peduncle and the color of the skin is olive green.

3. The top bulges remain elevated in relation to the point of inception of the peduncle and the color of the skin starts to turn from olive green to yellow.
  4. The pulp loses its consistency and the color of the skin turns completely yellow; the fruits are completely ripe.
- If by sectioning the peduncle, it is observed that the sap presents a violet coloration and is very fluid, it means that the fruit still is immature. As the picking stage approaches, the sap turns whitish, viscous, and dries rapidly.

#### a.2 External Appearance

- a. Variation of color and the aspect of the lenticels;
- b. Form of the tip in some varieties;
- c. Form of the apex, which turns well developed and rounded;
- d. Importance of the natural wax

#### a.3 Chemical Composition

The specific weight/starch relationship has been used in India in order to determine the rate of maturation. This density should be of over 1.0 (um)  $g/cm^3$ , and the starch 5% in order to affirm that the fruit is at the point of picking.

- Obs: This does not apply to varieties with hallow stones.

The soluble dry extract presents more secure results. Those fruits with a 12-15° BRIX measure ripen well after picking.

#### a.4 Texture

A penetrometer with a rod and a needle is used. The texture should be of  $2kg/cm^2$ . Three factors should be observed based on the optimum point of maturation:

- Density of the fruit between 1.01 - 1.02  $g/cm^3$ ;
- Resistance of the pulp to pressure between 1.75 - 2.0  $kg/cm^2$
- Soluble dry extract 12° to 15° BRIX

## 2. HARVEST

It consists of the picking of those fruits previously selected from trees.

One can proceed in two ways depending on the size of the cut of the peduncle:

- a. Short Peduncle
- b. Long Peduncle

#### a. SHORT PEDUNCLE

Cut the long peduncle with scissors from the lower parts of the tree and, for the higher parts, use a ladder and scissors, or poles of 4-6m in length with a sack affixed to a circle made of iron with a cutting blade on the extremity. Three to four fruits can be cut each time. Then, place the fruits carefully on the ground, on a clean and shaded area. Afterwards, hold each fruit with the peduncle pointing down and cut it right on the insertion base. Place the fruit back on the ground, inclined, in order to allow for the latex, or sap, to drain. Always be careful not to allow the latex to touch the nearby fruits.

**b. LONG PEDUNCLE**

Proceed in a manner similar to a., with the same care. What differs is the cut of the peduncle as to the base of insertion. It must have 1cm in length; this way, the latex will not drain and the fruit can be stored immediately.

**3. HANDLING OF THE FRUITS AND TRANSPORTATION TO THE PLACE OF PACKAGING**

All people involved in the handling of the fruits must have their nails trimmed short in order to avoid damaging them.

The fruits must be placed carefully in plastic containers of 15kg each. These containers must be lined with soft materials. Then, the containers must be put on carts and taken slowly to the storage facility.

Upon reception, the fruits must be washed with water in order to get rid of dust and latex and are, then, taken to the cleaning table where they go through a first classification (soft, defective, damaged, etc. fruits).

**4. POST-HARVEST PHITOSANITARY CARE**

Once cleaned and passed by first classification, a treatment is carried out.

There are several post-harvest treatments for mango, among which are:

a) Hot water	Immersion
b) Hot water + Fungicides	Immersion
c) Fungicides	Immersion
d) Wax + Fungicides	Pulverization
e) Hydrothermic Treatment	Immersion

**a) Hot Water > 54.4°C - 56°C for five (5) minutes.**

This treatment is the most efficient one to combat Antracnosis (*Colletotrichum Gloeosporioides*) and brown rot (*Dothionela ribis*).

**b) Hot Water + Fungicides at 54.4°C - 56°C for five (5) minutes.**

When the orchard is too infested or the variety is very sensitive, it is recommend to add the fungicide Benomyl or Methilic Thiofanate at 0.2%, and detergent, 0.1%.

The hot water accelerates the maturation of the fruits.

**c) Fungicides**

The objective is to control post-harvest diseases. Prepare a solution of Benomyl or Thiabendazole at 0.1% - 0.15% and immerse the fruits in it for five (5) minutes.

**d) Wax + Fungicides**

With the objective of prolonging the shelf life of the fruits and improving their external appearance, besides protecting them against diseases, some producers utilize liquid wax mixed with fungicides.

**e) Hydrothermic Treatment**

Whenever exporting to the United States and /or Japan, a treatment against the fruit fly is obligatory because these countries have eradicated this plague from their plantations. The treatment consists of immersion of the fruits in water at 46.1° for two (2) hours. Then, the fruits are stored in containers at 11°C for up to twenty (20) days.

## 5. CLASSIFICATION

After being treated and dried, the fruits are classified according to size manually or by classifying machines. At the classification stage it is necessary:

- a. not to mix varieties in the same container;
- b. to place in the same container fruits of same color, stage of maturation, size, and phitosanitary condition.
- c. to try to homogenize the position of the fruits in the same container. The classification is done by size and the people carrying out the classification are responsible for the other desirable characteristics such as coloration, stage of maturation, and position in the cartons and for discarding those undesirable characteristics in fruits such as those fruits which are unripe, colorless, scarred, damaged, soft, too ripe, attacked by insects (cochineal, thrips).

## 6. PACKAGING

The most frequently used package is a carton box with a capacity of 4 to 5kg, with good aeration. The packer places the fruits in the cartons in one layer only, homogenizing those characteristics which are demanded by the market. Each carton is then identified. Then, these cartons are piled up in separate lots and identified by type and stage of maturation. Afterwards, they are placed in wood and/or wood pallets and are ready for transportation or storage.

## 7. CONSERVATION

Whenever operating with boats, there is a need to store the product for some days at the port or the farm. This is done with the use of cold facilities or cold containers at a temperature of 12°C. These storage places must have equipment for the periodic renovation of air. Because air transportation is rapid, this type of storage is not necessary, and it becomes the responsibility of the importer.

## 8. TRANSPORTATION

When the fruits are stored in cold facilities or cold containers at the farm until the day of shipment, transportation to the port or airport must be done in cold trucks and taken straight to the ship or plane in cold containers which will provide continuity of the cold chain. Another possibility is to store the product directly at the port and/or airport until shipment to the final destination. In this case, the product is transported in trucks, at local temperature and, then, placed in the appropriate facilities, at 12°C, always being careful with the renovation of air liberating carbon dioxide, ethylene, and other gases which are harmful to the conservation of the fruits.