



EAST AFRICAN STANDARD

Bananas — Specification



EAST AFRICAN COMMUNITY

HS 0803.00.00

Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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Introduction

Bananas form an important part of trade across the borders of the EAC as well as international trade. This standard has been developed to facilitate this trade by emphasising on the quality factors and grading of bananas to attract commensurate pricing.

CODEX STAN 205:1997, AMD. 1-2005, *CODEX Standard for Bananas*

CODEX STAN 193:1995 (Rev.5:2009), *General Standard for Contaminants and Toxins in Foods*

CODEX STAN 228:2001 (Rev.1:2004), *General methods of analysis for contaminants*

Codex Alimentarius website: http://www.codexalimentarius.net/mrls/pestdes/jsp/pest_q-e.jsp

USDA Foreign Agricultural Service website: <http://www.mrlatabase.com>

USDA Agricultural Marketing Service website: <http://www.ams.usda.gov/AMSv1.0/Standards>

USDA Plant Inspectorate Service website: http://www.aphis.usda.gov/import_export/plants

European Union: http://ec.europa.eu/sanco_pesticides/public

Assistance derived from these sources and others inadvertently not mentioned is hereby acknowledged.

This standard has been developed to take into account:

- the needs of the market for the product;
- the need to facilitate fair domestic, regional and international trade and prevent technical barriers to trade by establishing a common trading language for buyers and sellers.
- the structure of the CODEX, UNECE, USA, ISO and other internationally significant standards;
- the needs of the producers in gaining knowledge of market standards, conformity assessment, commercial cultivars and crop production process;
- the need to transport the product in a manner that ensures keeping of quality until it reaches the consumer;
- the need for the plant protection authority to certify, through a simplified form, that the product is fit for crossborder and international trade without carrying plant disease vectors;
- the need to promote good agricultural practices that will enhance wider market access, involvement of small-scale traders and hence making fruit and vegetable production a viable means of wealth creation; and
- the need to keep unsatisfactory produce from the market by allowing the removal of unsatisfactory produce from the markets and to discourage unfair trade practices e.g. trying to sell immature produce at the beginning of the season when high profits can be made. Immature produce leads to dissatisfaction of customers and influences their choices negatively, which disadvantages those traders who have waited until the produce is mature.

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Bananas — Specification

1 Scope

This Standard applies to commercial varieties of bananas grown from *Musa* spp. (AAA), of the *Musaceae* family, in the green state, to be supplied fresh to the consumer, after preparation and packaging.

Bananas intended for cooking only (plantains) or for industrial processing are excluded. Varieties covered by this Standard are included in Annex A.

2 Normative references

The following referenced documents are indispensable for the application of this East African Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CAC/RCP 1, *Recommended international code of practice — General principles of food hygiene*

CAC/RCP 44, *Recommended international code of practice for packaging and transport of fresh fruits and vegetables*

CAC/RCP 53, *Code of hygienic practice for fresh fruits and vegetables*

CAC/GL 21, *Principles for the establishment and application of microbiological criteria for foods*

CODEX STAN 193, *General standard for contaminants and toxins in foods*

EAS 38, *Labelling of prepackaged foods*

CD/K/378:2010, *Horticultural industry — Code of practice*

3 Definitions

For the purpose of this standard the following definition shall apply:

3.1

blemish

any physical injury affecting the surface of the fruit, such as scars, healed cracks and discoloured spots, which detracts from its natural appearance, but will not significantly affect its shelf life

3.2

clean (visual)

the fruit shall be free from adhering soil, insects, chemical deposits and other foreign matter

3.3

cluster

part of a hand of bananas, normally distributed in two finger or five finger fruits

3.4

correct length

outer whorl fingers adjacent to cut side of the cluster, measurement of pulp from end to the base of pedicel on outer curve of the finger, found to be less or more than that specified based on market requirements

3.5

damage caused by pests

clusters showing cured damage to the peel due to the feeding or nesting of pests such as slugs, caterpillars, rodents or birds.

3.6

deflowered

the removal of the flower ends attached to clusters

3.7

disease

any defect or combination of defects caused by micro-organisms

3.8

finger end rot

abnormal constriction at the blossom-end and blackening of the pulp when split open

3.9

firm

not soft or shriveled

3.10

fresh

clusters showing colored crowns or pedicels or fruits which are not dehydrated

3.11

fused fingers

two or more fingers joined together

3.12

malformed finger

a unit or fingers on a cluster which do not conform to the general physical characteristics of the banana

3.13

turning

clusters showing yellowing of the pulp of a finger

4 Provisions concerning quality

4.1 General

The purpose of the standard is to define the quality requirements for bananas at the export control stage, after preparation and packaging.

The holder/seller of products may not display such products or offer them for sale, or deliver or market them in any manner other than in conformity with this standard. The holder shall be responsible for observing such conformity.

4.2 Minimum requirements

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

- whole (taking the finger as the reference);
- 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;
- practically free of pests affecting the general appearance of the produce;
- practically free of damage caused by pests;
- free of abnormal external moisture, excluding condensation following removal from cold storage, and bananas packed under modified atmosphere conditions;
- free of any foreign smell and/or taste;
- firm;
- fresh;
- free of damage caused by low temperatures;
- practically free of bruises;
- free of malformation or abnormal curvature of the fingers;
- with pistils removed (deflowered);
- with the stalk intact, without bending, fungal damage or desiccation.
- practically free from blemishes
- free from ripe and turning
- free from fused fingers
- free from finger end rot
- of the correct length

4.2.2 In addition, hands and clusters must include:

- a sufficient portion of the crown of normal colouring, sound and free of fungal contamination;
- a cleanly cut crown, not bevelled or torn, with no stalk fragments.

4.2.3 The development and condition of the bananas must be such as to enable them:

- to reach the appropriate stage of physiological maturity corresponding to the particular characteristics of the variety;
- to withstand transport and handling; and
- to arrive in satisfactory condition at the place of destination in order to ripen satisfactorily.

4.3 Classification

Bananas are classified in three classes defined below:

4.3.1 “Extra” Class

Bananas in this class must be of superior quality. They must be characteristic of the variety and/or commercial type. The fingers must be free of defects, with the exception of 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.

4.3.2 Class I

Bananas in this class must be of good quality. They must be characteristic of the variety. The following slight defects of the fingers, 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:

- slight defects in shape and colour;
- slight skin defects due to rubbing and other superficial defects not exceeding 2 cm² of the total surface area.

The defects must not, in any case, affect the flesh of the fruit.

4.3.3 Class II

This class includes bananas which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified in 4.2. The following defects, however, may be allowed, provided the bananas retain their essential characteristics as regards the quality, the keeping quality and presentation:

- defects in shape and colour, provided the product retains the normal characteristics of bananas;
- skin defects due to scraping, scabs, rubbing, blemishes or other causes not exceeding 4 cm² of the total surface area.

The defects must not, in any case, affect the flesh of the fruit.

5 Provisions concerning sizes

For the purposes of sizing bananas of the Gros Michel and Cavendish sub-groups, the length of the fingers is determined along the outside curve from the blossom end to the base of the pedicel where the edible pulp ends and the diameter is defined as the thickness of a transverse section between the lateral faces. The reference fruit for measurement of the length and grade is:

- for hands, the median finger on the outer row of the hand;
- for clusters, the finger next to the cut section of the hand, on the outer row of the cluster.

The minimum length should not be less than 14.0 cm and the minimum grade not less than 2.7 cm.

6 Provisions concerning tolerances

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

6.1 Quality tolerances

6.1.1 “Extra” Class

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

6.1.2 Class I

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

6.1.3 Class II

Ten percent by number or weight of bananas satisfying neither the requirements of the class nor the minimum requirements, with the exception of produce affected by rotting, major imperfections or any other deterioration rendering it unfit for consumption.

6.2 Size tolerances

For all classes, 10% by number or weight of bananas not satisfying the requirements as regards sizing, but falling within the size immediately above or below those indicated in Section 3.

7 Provisions concerning presentation

7.1 Uniformity

The contents of each package must be uniform and contain only bananas of the same origin, variety, and quality. The visible part of the contents of the package must be representative of the entire contents.

7.2 Packaging

Bananas must be packed in such a way as to protect the produce properly. The materials used inside the package must be new¹⁾, clean, and of a quality such as to avoid causing any external or internal damage to the produce. 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.

Bananas shall be packed in each container in compliance with CAC/RCP 44.

7.2.1 Description of containers

The containers shall meet the quality, hygiene, ventilation and resistance characteristics to ensure suitable handling, shipping and preserving of the bananas. Packages must be free of all foreign matter and smell.

7.3 Presentation

- The bananas must be presented in hands and clusters (parts of hands) of at least four fingers. Bananas may also be presented as single fingers;
- Clusters with no more than two missing fingers are allowed, provided the stalk is not torn but cleanly cut, without damage to the neighbouring fingers;
- Not more than one cluster of three fingers with the same characteristics as the other fruit in the package may be present per row.

8 Marking or labelling

8.1 Consumer packages

In addition to the requirements of EAS 38, the following specific provisions apply:

8.1.1 Nature of produce

If the produce is not visible from the outside, each package shall be labelled as to the name of the produce and may be labelled as to name of the variety.

8.2 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.

¹⁾ For the purposes of this Standard, this includes recycled material of food-grade quality.

8.2.1 Identification

Name and address of exporter, packer and/or dispatcher. Identification code (optional)²⁾.

8.2.2 Nature of produce

Name of the produce if the contents are not visible from the outside. Name of the variety or commercial type (optional).

8.2.3 Origin of produce

Country of origin and, optionally, district where grown or national, regional or local place name.

8.2.4 Commercial Identification

— Bananas in fingers (when appropriate);

— Class;

— Net weight (optional);

8.2.5 Official Inspection Mark (optional)**9 Contaminants****9.1 Heavy metals**

Bananas shall comply with those maximum levels for heavy metals established by the Codex Alimentarius Commission for this commodity.

9.2 Pesticide residues

Bananas shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity.

Maximum pesticide residue limits and extraneous maximum residue limits in bananas (current as at 2009-06-07)

| Type | Unit symbol | Limit | Method of test | Notes |
|----------------------|-----------------|-------|----------------|--------------------------------------|
| BITERTANOL | MRL (mg/kg) | 0.5 | | |
| BOSCALID | MRL (mg/kg) | 0.2 | | |
| CADUSAFOS | MRL (mg/kg) (*) | 0.01 | | |
| CARBENDAZIM | MRL (mg/kg) | 0.2 | | |
| CARBOFURAN | MRL (undef) (*) | 0.1 | | |
| CHLOROTHALONIL | MRL (mg/kg) (*) | 0.01 | | Based on trials with bagged bananas. |
| CHLORPYRIFOS | MRL (undef) | 2 | | |
| DIFENOCONAZOLE | MRL (mg/kg) | 0.1 | | |
| DITHIOCARBAMATES | MRL (undef) | 2 | | Source of data: mancozeb |
| ETHOPROPHOS | MRL (undef) | 0.02 | | |
| FENAMIPHOS | MRL (mg/kg) (*) | 0.05 | | |
| FENARIMOL | MRL (mg/kg) | 0.2 | | |
| FENBUCONAZOLE | MRL (mg/kg) | 0.05 | | |
| FENBUTATIN OXIDE | MRL (mg/kg) | 10 | | |
| FENPROPIMORPH | MRL (undef) | 2 | | |
| FIPRONIL | MRL (mg/kg) | 0.005 | | |
| FLUSILAZOLE | MRL (mg/kg) | 0.03 | | |
| GLUFOSINATE-AMMONIUM | MRL (mg/kg) | 0.2 | | |

²⁾ The national legislation of a number of countries requires the explicit declaration of the name and address. However, in the case where a code mark is used, the reference "packer and/or dispatcher (or equivalent abbreviations)" has to be indicated in close connection with the code mark.

| | | | | |
|-----------------|-----------------|------|--|------------------------------|
| GLYPHOSATE | MRL (undef) (*) | 0.05 | | |
| HALOXYFOP | MRL (mg/kg) (*) | 0.05 | | |
| IMAZALIL | MRL (mg/kg) P | 2 | | |
| IMIDACLOPRID | MRL (mg/kg) | 0.05 | | |
| MYCLOBUTANIL | MRL (mg/kg) | 2 | | |
| PROPICONAZOLE | MRL (undef) | 0.1 | | |
| PYRACLOSTROBIN | MRL (undef) (*) | 0.02 | | |
| PYRIMETHANIL | MRL (mg/kg) | 0.1 | | |
| TEBUCONAZOLE | MRL (mg/kg) | 0.05 | | |
| TERBUFOS | MRL (undef) | 0.05 | | |
| THIABENDAZOLE | MRL (mg/kg) P | 5 | | Used also as veterinary drug |
| TRIADIMENOL | MRL (undef) | 0.2 | | Source of data: triadimenol |
| TRIFLOXYSTROBIN | MRL (undef) | 0.05 | | |

10 Hygiene

10.1 It is recommended that the produce covered by the provisions of this East African Standard be prepared and handled in accordance with the appropriate sections of CAC/RCP 1, CAC/RCP 53, and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

10.2 The produce should comply with any microbiological criteria established in accordance with CAC/GL 21.



Fresh ripe banana



Ripening stages



Ripe bananas

Draft for comment



Growing bananas



Ripe banana

Draft for



Draft for comments only — Not to be used for East African Standard

Annex A
(informative)

List of the main groups, sub-groups and cultivars of bananas for dessert

| Groups | Subgroups | Main cultivar |
|--------|--------------|---|
| AA | Sweet-fig | Sweet-fig, Pisang Mas, Amas Date, Bocadillo |
| AB | Ney Poovan | Ney Poovan, Safet Velchi |
| AAA | Cavendish | Dwarf Cavendish |
| | | Giant Cavendish |
| | | Lacatan |
| | | Poyo (Robusta) Williams |
| | Americani | |
| | Valery Arvis | |
| | Gros Michel | Gros Michel Highgate |
| | Pink Fig | Pink Fig Green pink Fig |
| | Ibota | |
| AAB | Apple Fig | Apple Fig, Silk |
| | Pome (prata) | Pacovan Prata Ana |
| | Mysore | Mysore, Pisang Ceylan, Gorolo |

Annex B (informative)

Green bananas — Guide to storage and transport

B.1 Scope and field of application

This annex describes conditions for the successful keeping, with or without artificial cooling, of green bananas, *Musa sp.*, in the preclimacteric phase during storage before transport from the place of production to the place of consumption and during maritime transport.

Bananas should be stored, before transport from the exporting country to the place of consumption and throughout the period of transport, in the green condition and, therefore in the preclimacteric phase.

A banana is said to be in the preclimacteric phase when the process of ripening has not yet been initiated.

Harvesting of bananas takes place throughout the year in tropical and sub-tropical regions having considerable variations of an ecological and climatic kind. It follows that the state of dimensional development (fullness) of the banana does not afford a precise criterion of its degree of ripeness. A thin banana (in a period of drought) may be in an advanced degree of ripeness.

Moreover, the degree of ripeness to be chosen depends on the duration of transport, which varies considerably (from a few days to 3 weeks).

The producer should time the cutting of the bananas so that the degree of ripeness (as estimated from their fullness) is compatible with the transport envisaged. The time of cutting therefore depends on two distinct factors: the duration of refrigerated transport and the physiological state of the banana. For this reason the recommendations for the degree of ripeness (see B.2.1) cannot be universally applicable and can be only of a general nature which serve as a pointer to the producer, who has to decide on his own criteria for cutting.

As regards examination for ripeness, a bunch of bananas may be likened to a bunch of grapes with fruit in different states of ripeness, and it is therefore essential to specify with what fruit the check is to be carried out.

The state of the bananas (state of health, wounds, etc.), when they enter the store, has an influence on the storage life, and this is the justification for making recommendations on this subject.

The same applies to the precautions to be taken between harvesting the bananas and putting them into the store. The high temperature of the producing areas and exposure to sunlight can appreciably reduce the storage life.

The term cultivar is used to indicate that the varieties of bananas entering into commerce are cultivated varieties.

Anti-fungal treatments of the ends of the main stalk or ends of the cushions have not been mentioned, because it is not possible to indicate treatments which are recognized beyond dispute.

B.2 Conditions of harvesting and putting into store

B.2.1 Harvesting

The degree of ripeness of the banana at harvesting should be determined as a function of its firmness and the number of days elapsing between harvesting and putting into the ripening room. It should not be too advanced, in order that the bananas may remain in the preclimacteric phase until they are put into the ripening room in normal conditions of transport.

B.2.1.1 Criteria of ripeness

The criteria of ripeness most generally used in practice are :

- the fullness, which is a dimensional criterion;
- the colour of the flesh, which is a criterion of the physiological state and is assessed by means of a conventional colour scale enabling a numerical value to be obtained;
- the firmness of the flesh, which is a criterion of the physiological state and is measured by means of a spring penetrometer (with a cylindrical end 4 mm in diameter, and a spring which is reduced in length by 100 mm under a force of 24.5 N);
- the characteristic odour of the flesh of the banana in the preclimacteric phase.

These criteria are not universally valid and, for each cultivar grown in the same way, they can vary from one region to another, and the producer should decide on his own criteria for cutting.

B.2.1.2 Examination for degree of ripeness

Examination for the degree of ripeness of a bunch of bananas should be carried out by using the representative fruit found in that part of the bunch which is in the most advanced state of ripeness, i.e. in the first or second hand reckoned from the largest end of the main stalk. The representative fruit is the centre fruit of normal shape in the inside row of the first or second hand. The degrees of ripeness of the fruits of the first and second hand can be considered as equal.

B.2.2 Quality characteristics for storage and transport

The bananas should be free from signs of attack by fungi, bacteria, insects or animal pests, and should be free from parasites. They should not be injured by fungal or physiological diseases.

In order to avoid the development of fungal diseases during storage, the fruit should be clean. It should not be stained with sap and the fruit stalks should be intact. The main stalk of the bunches should not show marks of sunburn and its two sections should be fresh, clean, and without smears, tears or breaks.

The bananas should be free from evident marks of rubbing, scraping, bruising or sunburn.

Removal of the pistils should be carried out in those producing areas where the climate and conditions of cultivation favour the development of rot. It should be carried out on the tree itself if the size of the banana tree allows this.

B.2.3 Putting into store

The bananas should be put into cold store for long journeys, or into ventilated store for short journeys, as soon as possible after harvesting. The interval between cutting the bunch and putting it into a refrigerated or ventilated enclosure (prerrefrigeration room, storage room or ship's hold) should be less than 24 h if possible, and should not in any case exceed 48 h.

After harvesting and packaging, if the bananas are awaiting land transport to the port of embarkation, they should be put in the shade and in a well ventilated place.

At the port of embarkation, the waiting time of lorries or wagons loaded with bananas, before transfer to the ship's holds, should be reduced to the minimum and the vehicles should be in the shade.

B.2.4 Method of storage

Green bananas should be stored:

- in hands or portions of hands (clusters) in cartons;
- in bunches, in bags of perforated polyethylene;
- in bunches, enclosed in a protective mattress which allows gas exchange and has a thermal conductance sufficient to ensure satisfactory cooling (straw, paper, etc.);
- in uncovered bunches, arranged in bulk. This method of storage should be carried out with very great care in order to avoid damaging the bananas, which would lead to deterioration during transport and ripening.

B.3 Optimum storage and transport conditions (with artificial cooling)

Refrigerated storage and transport of green bananas comprises two phases: cooling and storage.

B.3.1 Cooling

B.3.1.1 Rate of cooling

Cooling of the bananas should be carried out as rapidly as possible. It depends on the following factors:

Cooling of the bananas should be carried out as rapidly as possible. It depends on the following factors:

- the power of the refrigeration plant (of the order of 700 to 800 calories per hour per tonne of bananas). With a central refrigeration plant, and loading of the banana vessel divided between two days, it is possible to apply the whole of the refrigerating power of the vessel to the first half of the cargo from the start of refrigeration and to dispose of more than 1 000 calories per hour per tonne of bananas;
- the air circulation ratio¹ in each ventilation section;
- the uniformity and speed of the air circulation across the load
- the surface of each package in contact with the cooling air;
- the efficiency of ventilation (effect of external and internal short-circuits of the air);
- the mode of packaging (polyethylene wrappers or cardboard boxes of different kinds);
- the method of storage (compact or in stacks);
- the method of loading the banana vessel (continuously or in 2 days with an interval of 12 h at night).

B.3.1.2 Temperature

The temperature of the bananas is lowered from 25 to 30 °C, which is that of the bananas on loading into the ship's holds, to the practical storage temperature (see B.3.2.1).

B.3.1.3 Relative humidity

The relative humidity of the air at the delivery side varies whilst the bananas are being cooled because the working range of the cold batteries is not stable. It increases at the end of cooling, when it should lie between 85 and 90 % at the entry of the delivered air into the banana compartments.

¹ Air-circulation ratio is defined as the ratio of the volume of air passed in 1 h by the fans to the volume of the empty chamber.

B.3.1.4 Air circulation

An air circulation ratio of 80 to 100 per ventilation section (collection of compartments, usually two, depending on the same fan or fans) is recommended.

The ventilation system recommended is that with vertically ascending or descending air in series (two compartments superimposed and separate by a slatted floor), with a uniform distribution of air over the surface at the suction side or the delivery side. Each compartment is traversed by all the air delivered by the fans and consequently its air circulation coefficient is double that of the ventilation section.

The rate of air change² recommended is one change per hour, but it may be reduced to half a change per hour during cooling in order not to retard this.

B.3.2 Storage**B.3.2.1 Temperature**

Throughout the period of maritime transport, after cooling of the bananas, it is necessary to ensure that the practical storage temperature of the delivery air is maintained at the value adopted. This is achieved by adding to the critical storage temperature (the temperature which induces damage to the bananas due to cold) a safety margin sufficient to take account of unavoidable temperature fluctuations arising from the refrigeration plant and its operation (+0.2 to +0.5 °C for a refrigeration plant using brine; +0.5 to +0.7 °C for a direct expansion plant).

The critical temperature for bananas is not constant, its value depending on the cultivar considered, on the degree of maturity of the crop, its sanitary state, and the duration of the maritime transport.

The following values are given as indications only:

| Cultivar | Period of storage days | Critical temperature ³ °C |
|--------------------------------|---------------------------|---|
| Gros Michel | 12 | 12 |
| Lacatan | 11 to 13 | 14.4 |
| Poyo (Robusta) | 14 | 12 |
| Grande naine (Giant Governor) | 14 | 12 |
| Petite naine (Dwarf Cavendish) | 16 | 12 |

B.3.2.2 Relative humidity

The surface of the air coolers should be designed so that a relative humidity of 85 to 90 % is obtained at the cold point of the refrigerated enclosure in the stabilization period when the cooling of the bananas is completed.

B.3.2.3 Air circulation

During storage, the air circulation ratio may be reduced to half after the end of the cooling period.

The recommended rate of air change is one change per hour.

B.3.2.4 Ripening

Ripening of the bananas during storage should be avoided by all possible means. Ripening is accompanied by an increase in the production of carbon dioxide and by the production of ethylene, which is liable to trigger the ripening of the adjacent bananas.

² The rate of air change is the ratio of the volume of outside air introduced into the refrigerated enclosure in 1 h to the volume of the empty enclosure.

³ Critical temperature is the temperature from which or below which, for a given period of storage, physiological disorders are produced or it is not possible to obtain normal ripening when the product is taken out of storage.

Experience in storage shows that with an efficient ventilation system, ensuring continuous sweeping of all parts of the load by the air circulating in the holds of banana vessel, and with continuous changes of fresh air, carbon dioxide and ethylene can be removed without any action on the adjacent fruit.


The occurrence of an abnormal percentage of ripe bananas on discharge of the banana vessel arises from four causes which should be avoided:

- keeping at ambient temperature at the port of arrival;
- loading of bananas at too advanced a stage of ripeness;
- defects in ventilation;
- defects in the refrigeration plant.

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Annex C
(informative)

Model certificate of conformity with standards for fresh fruits and vegetables

| | | | |
|--|--|---|----------------------------|
| 1. Trader: | Certificate of conformity with the Community marketing standards applicable to fresh fruits and vegetables No. (This certificate is exclusively for the use of inspection bodies) |  | |
| 2. Packer identified on packaging (if other than trader) | 3. Inspection body | | |
| | 4. Place of inspection/country of origin ⁽¹⁾ | 5. Region or country of destination | |
| 6. Identifier of means of transport | 7. <input type="checkbox"/> Internal <input type="checkbox"/> Import <input type="checkbox"/> Export | | |
| 8. Packages (number and type) | 9. Type of product (variety if the standards specifies) | 10. Quality Class | 11. Total net weight in kg |
| <p>12. The consignment referred to above conforms, at the time of issue, with the Community standards in force, vide:</p> <p><u>CD/K/109:2008, Fresh bananas — Specification and grading</u></p> <p>_____</p> <p>Customs office foreseen Place and date of issue</p> <p>Valid until (date):</p> <p>Signatory (name in block letters):</p> <p>Signature _____ Seal of competent authority _____</p> | | | |
| 13. Observations: | | | |
| ⁽¹⁾ Where the goods are being re-exported, indicate the origin in box 9. | | | |

Annex D
(informative)

Banana — Fact sheets

D.1 *Musa acuminata*



| | |
|---------------------|---|
| Authority | Colla |
| Family | Liliopsida:Zingiberidae:Zingiberales:Musaceae |
| Synonyms | |
| Common names | |
| Editor | |
| Ecocrop code | 7848 |

Description

A herbaceous plant with a fleshy, watery stem made up of large, spirally arranged, overlapping leaf bases called sheaths. The plant stands erect, 1.5-6 m tall and the stem has a diameter of up to 30 cm at the base. Leaves are 1-2 m long and up to 60 cm wide. The inflorescence is horizontal or pendulous. Fruits may be 10-25 cm long, green, yellow or brown, cylindric or angled, and seeded or seedless.

Uses

It is mainly grown for its edible fruits. The ripe fruit is eaten fresh, baked, fried, or roasted and is made into a type of vinegar, and it also has medicinal properties. Young stalks and leaves are fed to livestock and leaves are used for wrapping foods, for cooking and as plates. The underground stem can be eaten as a vegetable.

Killing temperature

Depending on the cultivar banana may be killed by frost and damage when the temperature falls below 7-12°C for more than 12 hours or it may withstand

D.2 *Musa acuminata x balbisiana*



| | |
|---------------------|---|
| Authority | Liliopsida:Zingiberidae:Zingiberales:Musaceae |
| Family | |
| Synonyms | |
| Common names | Banana, Pisang rastali, Tundan, Turdan, Tordan, Latunda, Cantong, Letundal. (see <i>M. acuminata</i>). |
| Editor | |
| Ecocrop code | 7849 |

Description

A herbaceous plant with a fleshy, watery stem made up of large, spirally arranged, overlapping leaf bases called sheaths. The plant stands erect, 1.5-6 m tall and the stem has a diameter of up to 30 cm at the base. Leaves are 1-2 m long and up to 60 cm wide. Fruits may be 10-25 cm long, green, yellow or brown, cylindrical or angled, and seeded or seedless.

Uses

It is mainly grown for its edible fruits. The ripe fruit is eaten fresh, baked, fried, or roasted and is made into a type of vinegar, and it also have medicinal properties. Young stalks and leaves are fed to livestock and leaves are used for wrapping foods, for cooking and as plates. The underground stem can be eaten as a vegetable.

Growing period

Perennial

D.3 *Musa balbisiana*



Authority

Family

Liliopsida:Zingiberidae:Zingiberales:Musaceae

Synonyms

Common names

Plantain banana, Saba, Dippig, Saging, Bisce, Opispo.

Editor

Ecocrop code

2507

Description

A plant with a fleshy, watery stem made up of large, spirally arranged, overlapping leaf bases called sheaths. The plant stands erect, 1.5-6 m tall and the stem has a diameter of up to 30 cm at the base. Leaves are 1-2 m long and up to 60 cm wide. The inflorescence is horizontal or pendulous. Fruits may be 10-25 cm long, green, yellow or brown, cylindrical or angled, and seeded or seedless.

Uses

It is mainly grown for its edible fruits. The ripe fruit is boiled, baked, fried, or roasted and is made into a type of vinegar, and it also have medicinal properties. Young stalks and leaves are fed to livestock and leaves are used for wrapping foods, for cooking and as plates. The underground stem can be eaten as a vegetable.

Killing temperature

Damaged at temperatures below 8-12°C.

Growing period

Giant French plantains (15-18 months), Medium French plantains (12-15 months) and False Horn plantains (12 months).

Further information

Scientific synonym: *M. brachycarpa*. Plantains wild ancestors can still be found in the forests of the eastern part of India and in the Malesian area. In the humid tropics, it can be found at elevations between sea level and 1200 m. In the wild it occur mainly in forests, on forest edges, in ravines and on water sides. It is sensitive to strong winds. Mentioned as a possible agroforestry species.

D.4 *Musa halabanensis*

| | |
|---------------------|---|
| Authority | Meijer |
| Family | Liliopsida:Zingiberidae:Zingiberales:Musaceae |
| Synonyms | |
| Common names | Banana, Bananier, Pisang, Saging, Sulay baguio, Bungulan, Lakatan, Nget pyo three, Cheek nam'vaa, Kwayz, Kluai. |
| Editor | |
| Ecocrop code | 7852 |

Description

A large herb up to 9 m tall, gigantic in all its parts, with a short underground stem and a pseudostem consisting of overlapping leaf-sheaths which are tightly rolled round each other to form a rigid bundle.

Uses

The inflorescence is used as a vegetable, the inner part is eaten raw with fried noodles, after boiling in water, or after roasting in hot ashes. It can also be used in soups. The lower, soft inner part of the pseudostem is also eaten fresh or boiled with a capsicum sauce or curries.

Growing period

Perennial.

Further information

Banana (*halabanensis*) is native of West Sumatra. In the tropics, it can be found at elevations between sea level and 1800 m. In the wild it occurs mainly in forests, on forest edges, in ravines and on water sides. It is sensitive to strong winds.

D.5 *Musa salaccensis*

| | |
|---------------------|---|
| Authority | Zoll |
| Family | Liliopsida:Zingiberidae:Zingiberales:Musaceae |
| Synonyms | |
| Common names | Banana, Bananier, Pisang, Saging, Sulay baguio, Bungulan, Lakatan, Nget pyo three, Cheek nam'vaa, Kwayz, Kluai. |
| Editor | |
| Ecocrop code | 7856 |

Description

A small herb, not more than 3 m tall, with a short underground stem and a pseudostem consisting of overlapping leaf-sheaths which are tightly rolled round each other to form a rigid bundle and an erect inflorescence.

Uses

The bitter tasting inflorescence is used as a vegetable, the inner part is eaten raw with fried noodles, after boiling in water, or after roasting in hot ashes. It can also be used in soups. The lower, soft inner part of the pseudostem is also eaten fresh or boiled with a capsicum sauce or curries.

Growing period

Perennial.

Further information

Banana (*salaccensis*) is native of Sumatra and Java. In the humid tropics, it can be found at elevations between sea level and 1200 m. In the wild it occur mainly in forests, on forest edges, in ravines and on water sides. It is sensitive to strong winds.

D.6 *Musa sapientum*

Authority
Family
Synonyms
Common names

L.
Liliopsida:Zingiberidae:Zingiberales:Musaceae
Musa cv. L., Musa sinensis, Musa paradisiaca L.
common banana, banana, plantain, broadleaf plantain, dessert banana, dwarf cavendish, banane, liwii, nas, navits, vii, meika (Cook I), vudi ni vavalagi, vudi, dini, vuda ni vavalagi, si, te banana (Kiribati), futi (Niue), fusi (Niue), hopa (Tonga), fai (Samoa), fai'i (Samoa), vudi (Simbo), hakua (Roviana), piesang (Afrikaans), futi (Tuvalu)

Editor
Ecocrop code

1503

D.7 *Musa sp.*

Authority
Family
Synonyms
Common names

L.
Liliopsida:Zingiberidae:Zingiberales:Musaceae
banana, bananier, pisang, saging, nget pyo thee, cheek ham' vaa, kwhyz, kluai, chuoi, muz

Editor
Ecocrop code

2483

D.8 Banana — *Musa x paradisiaca*

The word "banana" is a general term embracing a number of species or hybrids in the genus *Musa* of the family Musaceae. Some species such as *M. Basjoo* Sieb. & Zucc. of Japan and *M. ornata* Roxb., native from Pakistan to Burma, are grown only as ornamental plants or for fiber. *M. textilis* Nee of the Philippines is grown only for its fiber, prized for strong ropes and also for tissue-thin tea bags. The so-called Abyssinian banana, *Ensete ventricosum* Cheesman, formerly *E. edule* Horan, *Musa ensete* Gmel., is cultivated in Ethiopia for fiber and for the staple foods derived from the young shoot, the base of the stem, and the corm.

Most edible-fruited bananas, usually seedless, belong to the species *M. acuminata* Colla (*M. cavendishii* Lamb. ex Paxt., *M. chinensis* Sweet, *M. nana* Auth. NOT Lour., *M. zebrina* Van Houtee ex Planch.), or to the hybrid *M. X paradisiaca* L. (*M. X sapientum* L.; *M. acumianta* X *M. balbisiana* Colla).

M. balbisiana Colla of southern Asia and the East Indies, bears a seedy fruit but the plant is valued for its disease-resistance and therefore plays an important role as a "parent"; in the breeding of edible bananas.

M. fehi Bertero ex Vieill. and *M. troglodytarum* L. have been applied to the group of bananas known as fehi or fe'i but taxonomists have yet to make final decisions as to the applicability of these binomials.

To the American consumer, "banana"; seems a simple name for the yellow fruits so abundantly marketed for consumption raw, and "plantain"; for the larger, more angular fruits intended for cooking but also edible raw when fully ripe. However, the distinction is not that clear and the terms may even be reversed. The types we call "banana"; are known by similar or very different names in banana-growing areas. Spanish-speaking people say *banana china* (Paraguay), *banano enano* (Costa Rica), *cambur* or *camburi* (Colombia, Venezuela), *cachaco*, *colicero*, *cuatrofilos* (Colombia); *carapi* (Paraguay), *curro* (Panama), *guineo* (Costa Rica, Puerto Rico, El Salvador); *murrapo* (Colombia); *mampurro* (Dominican Republic); *patriota* (Panama); *platano* (Mexico); *platano de seda* (Peru); *platano enano* (Cuba); *suspiro* (Dominican Republic); *zambo* (Honduras). Portuguese names in Brazil are: *banana maca*, *banana de Sao Tome'*, *banana da Prata*. In French islands or areas, the terms may be *bananier nain*, *bananier de Chine* (Guadeloupe), *figue*, *figue banane*, *figue naine* (Haiti). Where German is spoken, they say: *echte banane*, *feige*, or *feigenbaum*. In the Sudan, *baranda*.

The types Americans call "plantain"; may be known as *banaan* (Surinam); *banano macho* (Panama); *banane* or *bananier* (Haiti, Guadeloupe, Martinique); *banane misquette* or *banane musquee*, or *pie banane* (Haiti); *bananeira de terra* (Brazil); *banano indio* (Costa Rica); *barbaro* (Mexico); *butuco* (Honduras); *parichao* (Venezuela); plantain (Guyana, Jamaica, Trinidad); *platano* (Cuba, Puerto Rico, Dominican Republic); *platano burro*, *platano hembra* (Cuba); *platano macho* (Cuba, Panama); *platano de la isla* (Peru); *topocho* or *yapuru* (Venezuela); *zapolote* (Mexico). Numerous other vernacular names exist according to geographical region.

In India, there is no distinction between bananas and plantains. All cultivars are merely rated as to whether they are best for dessert or for cooking.

Description

The banana plant, often erroneously referred to as a "tree", is a large herb, with succulent, very juicy stem (properly "pseudostem") which is a cylinder of leaf-petiole sheaths, reaching a height of 6-7.5 m and arising from a fleshy rhizome or corm. Suckers spring up around the main plant forming a clump or "stool", the eldest sucker replacing the main plant when it fruits and dies, and this process of succession continues indefinitely. Tender, smooth, oblong or elliptic, fleshy-stalked leaves, numbering 4 or 5 to 15, are arranged spirally. They unfurl, as the plant grows, at the rate of one per week in warm weather, and extend upward and outward, becoming as much as 2.75 m long and 60 cm wide. They may be entirely green, green with maroon splotches, or green on the upper side and red purple beneath. The inflorescence, a transformed growing point, is a terminal spike shooting out from the heart in the tip of the stem. At first, it is a large, long-oval, tapering, purple-clad bud. As it opens, it is seen that the slim, nectar-rich, tubular, toothed, white flowers are clustered in whorled double rows along the floral stalk, each cluster covered by a thick, waxy, hoodlike bract, purple outside, deep-red within. Normally, the bract will lift from the first hand in 3 to 10 days. If the plant is weak, opening may not occur until 10 or 15 days. Female flowers occupy the lower 5 to 15 rows; above them may be some rows of hermaphrodite or neuter flowers; male flowers are borne in the upper rows. In some types the inflorescence remains erect but generally, shortly after opening, it begins to bend downward. In about one day after the opening of the flower clusters, the male flowers and their bracts are shed, leaving most of the upper stalk naked except at the very tip where there usually remains an unopened bud containing the last-formed of the male flowers. However, there are some mutants such as 'Dwarf Cavendish' with persistent male flowers and bracts which wither and remain, filling the space between the fruits and the terminal bud.

As the young fruits develop from the female flowers, they look like slender green fingers. The bracts are soon shed and the fully grown fruits in each cluster become a "hand" of bananas, and the stalk droops with the weight until the bunch is upside down. The number of "hands" varies with the species and variety.

The fruit (technically a "berry") turns from deep-green to yellow or red, or, in some forms, green-and white-striped, and may range from 6.4-30 cm in length and 1.9-5 cm in width, and from oblong, cylindrical and blunt to pronouncedly 3-angled, somewhat curved and hornlike. The flesh, ivory-white to yellow or salmon-yellow, may be firm, astringent, even gummy with latex, when unripe, turning tender and slippery, or soft and mellow or rather dry and mealy or starchy when ripe. The flavour may be mild and sweet or subacid with a distinct apple tone. Wild types may be nearly filled with black,

hard, rounded or angled seeds 3-16 mm wide and have scant flesh. The common cultivated types are generally seedless with just minute vestiges of ovules visible as brown specks in the slightly hollow or faintly pithy centre, especially when the fruit is overripe. Occasionally, cross-pollination by wild types will result in a number of seeds in a normally seedless variety such as 'Gros Michel', but never in the Cavendish type.

Origin and distribution

Edible bananas originated in the Indo-Malaysian region reaching to northern Australia. They were known only by hearsay in the Mediterranean region in the 3rd Century B.C., and are believed to have been first carried to Europe in the 10th Century A.D. Early in the 16th Century, Portuguese mariners transported the plant from the West African coast to South America. The types found in cultivation in the Pacific have been traced to eastern Indonesia from where they spread to the Marquesas and by stages to Hawaii.

Bananas and plantains are today grown in every humid tropical region and constitute the 4th largest fruit crop of the world, following the grape, citrus fruits and the apple.

Varieties

Edible bananas are classified into several main groups and subgroups. Simmonds placed first the diploid *M. acuminata* group '**Sucrier**', represented in Malaya, Indonesia, the Philippines, southern India, East Africa, Burma, Thailand, the West Indies, Colombia and Brazil. The sheaths are dark-brown, the leaves yellowish and nearly free of wax. The bunches are small and the fruits small, thin-skinned and sweet. Cultivars of this group are more important in New Guinea than elsewhere.

Here belongs one of the smallest of the well-known bananas, the '**Lady Finger**', also known as 'Date' or 'Fig', and, in Spanish, as 'Dedo de Dama', 'Datil', 'Nino', 'Bocadillo', 'Manices', 'Guineo Blanco', or 'Cambur Titiaro'. The plant reaches 7.5 m in height, has a slender trunk but a heavy root system that fortifies the plant against strong winds. The outer sheaths have streaks or patches of reddish brown. The bunch consists of 10 to 14 hands each of 12 to 20 fingers. The fruit is 10-12.5 cm long, with thin, light-yellow skin and sweet flesh. This cultivar is resistant to drought, Panama disease and the black weevil but subject to Sigatoka (leaf spot). It is common in Latin America and commercial in Queensland and New South Wales.

In second place, there is the group represented by the prominent and widely cultivated '**Gros Michel**' originally from Burma, Thailand, Malaya, Indonesia and Ceylon. It was introduced into Martinique early in the 19th Century by a French naval officer and, a few years later, was taken to Jamaica; from there it was carried to Fiji, Nicaragua, Hawaii and Australia, in that sequence. It is a large, tall plant bearing long bunches of large, yellow fruits, and it was formerly the leading commercial cultivar in Central Africa, Latin America and the Caribbean, but has been phased out because of its great susceptibility to Panama disease. It has given rise to several named sports or mutants.

The Cavendish subgroup includes several important bananas:

- a) The '**Dwarf Cavendish**', first known from China and widely cultivated, especially in the Canary Islands, East Africa and South Africa. The plant is from 1.2 to 2.1 m tall, with broad leaves on short petioles. It is hardy and wind resistant. The fruit is of medium size, of good quality, but thin-skinned and must be handled and shipped with care. This cultivar is easily recognized because the male bracts and flowers are not shed.
- b) The '**Giant Cavendish**', also known as 'Mons Mari', 'Williams', 'Williams Hybrid', or 'Grand Naine', is of uncertain origin, closely resembles the 'Gros Michel', and has replaced the 'Dwarf' in Colombia, Australia, Martinique, in many Hawaiian plantations, and to some extent in Ecuador. It is the commercial banana of Taiwan. The plant reaches 2.7 to 4.9 m. The pseudostem is splashed with dark brown, the bunch is long and cylindrical, and the fruits are larger than those of the 'Dwarf' and not as delicate. Male bracts and flowers are shed, leaving a space between the fruits and the terminal bud.

- c) **'Pisang masak hijau'**, or 'Bungulan', the triploid Cavendish clone of the Philippines, Indonesia and Malaya, is erroneously called 'Lacatan' in Jamaica where it replaced 'Gros Michel' because of its immunity to Panama disease, though it is subject to Sigatoka (leaf spot). The plant is tall and slender and prone to wind injury. Its fruits ripen unevenly in winter, bruise easily and are inclined to spoil in storage. It is no longer grown commercially in Jamaica and the Windward Islands. The fruits are commonly used as cooking bananas in Jamaican households. Simmonds declares this cultivar is not the true 'Lacatan' of the Philippines. He suggested that 'Pisang masak hijau' may have been the primary source of all the members of the Cavendish group.
- d) **'Robusta'**, very similar to the so-called 'Lacatan', has largely replaced that cultivar in Jamaica and the Windward Islands and the 'Gros Michel' in Central America because it is shorter, thick-stemmed, less subject to wind. It is being grown commercially also in Brazil, eastern Australia, Samoa and Fiji. It is resistant to Panama disease but prone to Sigatoka.
- e) **'Valery'**, also a triploid Cavendish clone, closely resembles 'Robusta' and some believe it may be the same. However, it is being grown as a successor to 'Robusta'. It is already more widely cultivated than 'Lacatan' for export. As compared with other clones in cooking trials, it has low ratings because cooking hardens the flesh and gives it a waxy texture.

The Banana Breeding Research Scheme in Jamaica has developed a number of tetraploid banana clones with superior disease-resistance and some are equal in dessert quality to the so-called 'Lacatan' and 'Valery'.

'Bluggoe' (with many other local names) is a cooking banana especially resistant to Panama disease and Sigatoka. It bears a few distinctly separated hands of large, almost straight, starchy fruits, and is of great importance in Burma, Thailand, southern India, East Africa, the Philippines, Samoa, and Grenada.

'Ice Cream' banana of Hawaii ('Cenizo' of Central America and the West Indies; 'Krie' of the Philippines), is a relative of 'Bluggoe'. The plant grows to 3-4.5 m, the leaf midrib is light pink, the flower stalk may be several feet long, but the bunch has only 7 to 9 hands. The fruit is 17.5 to 22.8 cm long, up to 6.25 cm thick, 4-to 5-angled, bluish with a silvery bloom when young, pale yellow when ripe. The flesh is white, sweetish, and is eaten raw or cooked.

'Mysore', also known as 'Fillbasket' and 'Poovan', is the most important banana type of India, constituting 70% of the total crop. It is sparingly grown in Malaya, Thailand, Ceylon and Burma. It is thought to have been introduced into Dominica in 1900 but the only place where it is of any importance in the New World is Trinidad where it is cultivated as shade for cacao. The plant is large and vigorous, immune to Panama disease and nearly so to Sigatoka; very hardy and drought tolerant. It bears large, compact bunches of medium sized, plump, thin skinned, attractive, bright yellow fruits of subacid flavour.

Other prominent commercial cultivars are **'Salembale'** and **'Rasabale'**, not suitable for canning because of starchy taste and weak flavour. **'Pachabale'** and **'Chandrabale'** are important local varieties preferred for canning. K.C. Naik described 34 cultivars as the more important among the many grown in South India.

'Silk', 'Silk Fig', or 'Apple' ('Manzana' in Spanish), is the most popular dessert banana of the tropics. It is widely distributed around the tropics and subtropics but never grown on a large scale. The plant is 3 m to 3.6m tall, only medium in vigour, very resistant to Sigatoka but prone to Panama disease. There are only 6 to 12 hands in the bunch, each with 16 to 18 fruits. The plump bananas are 10-15 cm long, slightly curved; astringent when unripe but pleasantly subacid when fully ripe; and apple scented. If left on the bunch until fully developed, the thin skin splits lengthwise and breaks at the stem end causing the fruit to fall, but it is firm and keeps well on hand in the home.

The **'Red'**, 'Red Spanish', 'Red Cuban', 'Colorado', or 'Lal Kela' banana may have originated in India, where it is frequently grown, and it has been introduced into all banana growing regions. The plant is large, takes 18 months from planting to harvest. It is highly resistant to disease. The pseudostem, petiole, midrib and fruit peel are all purplish red, but the latter turns to orange yellow when the fruit is

fully ripe. The bunch is compact, may contain over 100 fruits of medium size, with thick peel, and flesh of strong flavour. In the mutant called 'Green Red', the plant is variegated green and red, becomes 8.5 m tall with pseudostem to 45 cm thick at the base. The bunch bears 4 to 7 hands, the fruits are thick, 12.5 to 17.5 cm long. The purplish-red peel changes to orange-yellow and the flesh is firm, cream-colored and of good quality.

The '**Fehi**' or 'Fe'i' group, of Polynesia, is distinguished by the erect bunches and the purplish-red or reddish-yellow sap of the plants which has been used as ink and for dyeing. The plants may reach 10.9 m and the leaves are 50-75 cm wide. The bunches have about 6 hands of orange or copper-coloured, thick skinned fruits which are starchy, sometimes seedy, of good flavour when boiled or roasted. These plants are often grown as ornamentals in Hawaii.

As a separate group, Simmonds places the 'I.C.2', or '**Golden Beauty**' banana especially bred at the Imperial College of Tropical Agriculture in Trinidad in 1928 by crossing the 'Gros Michel' with a wild *Musa acuminata*. It is resistant to Panama disease and very resistant to Sigatoka. Though the bunches are small and the fruits short, they ship and ripen well and this cultivar is grown for export in Honduras and has been planted in Hawaii, Samoa and Fiji.

'**Orinoco**', 'Horse', 'Hog', or 'Burro', banana, a medium tall, sturdy plant, is particularly hardy. The bunch consists of only a few hands of very thick, 3 angled fruits about 15 cm long. The flesh has a salmon tint, is firm, edible raw when fully ripe but much better cooked fried, baked or otherwise, as are plantains.

Trials of 5 clones of 'Giant Cavendish' and 9 other cultivars ('Robusta A', 'Robusta B', 'Cocos A', 'Cocos B', 'Golden Beauty', 'Enano Nautia', 'Enano Gigante', 'Enano' and 'Valery') were made between 1976 and 1979 at the Campo Agrícola Experimental at Tecoman, Mexico. 'Enano Gigante' is the most widely grown cultivar in that region but the tests showed that 'Enano Nautia' and 'Golden Beauty' bore heavier bunches of better quality fruit, even though 'Enano Gigante' had a greater number of bunches and highest yield per ground area. 'Giant Cavendish' clones 1, 2, 3 and 4, and 'Cocos B' grew very tall, gave low yields and the fruit was of poor quality.

Among the plantains, there are many forms, some with pink, red or dark-brown leaf sheaths, some having also coloured midribs or splotches on leaves or fruits. The plants are usually large, vigorous and resistant to Panama disease and Sigatoka but attacked by borers. Major subgroups are known as 'French plantain' and 'Horn plantain', the former with persistent male flowers. The usually large, angled fruits are borne in few hands. All are important sources of food in southern India, East Africa, tropical America and the West Indies. The tall '**Maricongo**' and the '**Common Dwarf**' are leading commercial cultivars. A dwarf mutant is the 'Plantano enano of Puerto Rico' (*'banane cochon'* of Haiti). Ordinary plantains are called '*cuadrado*', '*chato*', and '*topocho*' in Mexico. The leading commercial cultivars are 'Pelipita' and 'Saba' which are resistant to Black Sigatoka but they do not have the high culinary quality of 'Harton', 'Dominico-Harton', 'Currare', and 'Horn'. 'Laknau' is a fertile plantain that resembles 'Horn' but is of inferior quality. It has opened up possibilities for hybridizing and is being crossed with 'Pelipita' and 'Saba'.

Banana and plantain cultivars most often grown in Florida are the 'Dwarf Cavendish', 'Apple', and 'Orinoco' bananas and the 'Macho' plantain. The 'Red' and 'Lady Finger' bananas are very occasionally grown in sheltered locations.

There are five major collections of banana and plantain clones in the world. United Brands maintains a collection of 470 cultivars and 100 species at La Lima, Honduras.

Climate

The edible bananas are restricted to tropical or near-tropical regions, roughly the area between latitudes 30°N and 30°S. Within this band, there are varied climates with different lengths of dry season and different degrees and patterns of precipitation. A suitable banana climate is a mean temperature of 26.67°C and mean rainfall of 10 cm per month. There should not be more than 3 months of dry season.

Cool weather and prolonged drought retard growth. Banana plants produce only one leaf per month in winter, 4 per month in summer. If low temperatures occur just at flowering time, the bud may not be able to emerge from the stem. If fruits have already formed, maturity may be delayed several months or completely suspended. If only the leaves are destroyed, the fruits will be exposed to sunburn. Smudging, by burning dry trash covered with green clippings to create smoke, can raise the temperature 2 to 4 degrees. Flooding the field in advance of a cold snap will keep the ground warm if the chill weather is brief. In Australia, bananas are planted on sunny hill sides at elevations of 200 to 1,000 ft (60 to 300 m) to avoid the cold air that settles at lower levels. Brief frosts kill the plants to the ground but do not destroy the corm. 'Dwarf Cavendish' and the 'Red' banana are particularly sensitive to cold, whereas the dwarf cultivar 'Walha', or 'Kullen', of India is successful up to 4,000 ft (1,220 m) in the outer range of the Western Ghats. 'Vella vazhai' is extensively cultivated in the Lower Pulneys between 3,200 and 5,500 ft (975 and 1,616 m). A cooking banana, 'Plankel', survives winters in home gardens in northern India. In South Africa, the main banana-producing area is along the southeast coast at 3,000 ft (915 m) above sea level with summer rainfall of 35 to 45 in (90-115 cm). The major part of the crop in East Africa is grown between 4,000 and 5,000 ft (1,220 and 1,524 m) and the total range extends from sea-level to 7,500 ft (2,286 m).

Wind is detrimental to banana plants. Light winds shred the leaves, interfering with metabolism; stronger winds may twist and distort the crown. Winds to 30 mph break the petioles; winds to 40 mph will topple a pseudostem that is supporting the weight of a heavy bunch unless the stem is propped, and may cause root damage in non fruiting plants that are not blown down; winds of 60 mph or over will uproot entire plantations, especially when the soil is saturated by rain. Windbreaks are often planted around banana fields to provide some protection from cold and wind. Cyclones and hurricanes are devastating and the latter were the main reason for the shift of large scale banana production from the West Indies to Central America, Colombia and Ecuador. Hail results from powerful convection currents in the tropics, especially in the spring, and does much damage to bananas.

Soil

The banana plant will grow and fruit under very poor conditions but will not flourish and be economically productive without deep, well-drained soil—loam, rocky sand, marl, red laterite, volcanic ash, sandy clay, even heavy clay—but not fine sand which holds water. Over head irrigation is said to improve the filth of heavy clay and has made possible the use of clay soils that would never have been considered for banana culture in the past. Alluvial soils of river valleys are ideal for banana growing. Bananas prefer an acid soil but if the pH is below 5.0 lime should be applied the second year. Low pH makes bananas more susceptible to Panama disease. Where waterlogging is likely, bananas and plantains are grown on raised beds. Low, perennially wet soils require draining and dry soils require irrigation.

Propagation

Banana seeds are employed for propagation only in breeding programs. Corms are customarily used for planting and Mexican studies with 'Giant Cavendish' have shown that those over 8 kg in weight come into bearing early and, in the first year, the bunches are longer, heavier, with more hands than those produced from smaller corms. From the second year on, the advantage disappears. Most growers prefer "bits" 2- to 4-lb (0.9-1.8 kg) sections of the corm. When corms are scarce, smaller sections—1 to 2 lbs (454-908 g) have been utilized and early fertilization applied to compensate for the smaller size.

Inasmuch as "bits" are not often available in quantity, the second choice is transplantation of suckers. These should not be too young nor too old.

Instead of waiting for normal sucker development, multiplication has been artificially stimulated in the field by removing the soil and outer leaf sheaths covering the upper buds of the corm, packing soil around them and harvesting them when they have reached the "sword" sucker stage. A greenhouse technique involves cleaning and injuring a corm to induce callus formation from which many new plants will develop. As many as 180 plantlets have been derived from one corm in this manner.

Diseases are often spread by vegetative propagation of bananas, and this fact has stimulated efforts to create disease-free planting material on a large scale by means of tissue culture. Some commercial banana cultivars have been cultured in Hawaii. A million 'Giant Cavendish' banana plants were produced by meristem culture in Taiwan in 1983. In the field, these laboratory plantlets showed 95% survival, grew faster than suckers in the first 5 months, had bigger stems and more healthy leaves.

Culture

On level land where the soil is compact, deep ploughing is needed to improve aeration and water filtration, whereas on a sloping terrain minimum tillage is advised as well as contouring of rows to minimize erosion. Planting is best done at the end of the dry season and beginning of the wet season for adequate initial moisture and to avoid waterlogging of the young plants.

Spacing varies with the ultimate size of the cultivar, the fertility of the soil, and other factors. Close planting protects plantations exposed to high winds, but results in fewer suckers, hinders disease control, and has been found to be profitable for only the first year. In subsequent years, fruits are shorter, the flesh is softer and bunches ripen prematurely. The standard practice in Puerto Rico is 500 plants of 'Maricongo' plantain per acre (1,235 plants/ha). Increasing to 800 plants/acre (1,976/ha) has increased yield by 4 tons, but elevating density to 1,300 plants/acre (3,212 plants/ha) has not shown any further increase. In Surinam, most of the plantains are grown at a density of 809 to 1,012 plants per acre (2,000-2,500/ha), but density may range from 243 to 1,780 plants per acre (600-4,400/ha).

The higher the number of plants in the field, the larger the volume of fertilizer that must be applied. The crop suffers severely from root competition, for the roots of a fully grown banana plant may extend outward 5.5 m. The higher the altitude, the lower the density must be because solar radiation is reduced. Too much space between plants allows excessive evaporation from uncovered soil and increases the weed problem. Growers must determine the most economical balance between sufficient light for good yields and efficient land management. Spacing distances for 'Dwarf Cavendish' range from 3 x 1.8 m to 4.5 x 3.6 m. A spacing of 3.6 m between rows and 2.4 m between plants allows 450 plants per acre (1,112 plants/ha). Studies conducted with the so called 'Lacatan' ('Pisang masak hijau') over a 3-year period in Jamaica, demonstrated the optimum density to be 680 plants per acre (2,680/ha). At closer spacings, yield increased but profits declined. Hexagonal spacing gives the maximum number of plants per area. Double- and triple-row plantings provide alleys for mechanical operations and harvesting.

Planting holes should be at least 45 cm wide and 38 cm deep, but may be as much as 0.91 m wide and 0.6 m deep for extra wind resistance. They should be enriched in advance of planting. On hillsides, suckers are set with the cut surface facing downhill; the bud or "eye" of a "bit" must point uphill; so that the "follower" sucker will emerge on the uphill side where the soil is deepest. A surface cover of about 10 cm of soil is trampled down firmly.

Weed control is essential. Geese have been installed as weeders because they do not eat the banana plants. However, they consume mostly grass and fail to eliminate certain broad-leaved weeds which still require cleaning out. Certain herbicides, including Diuron and Ametryne, have been approved for banana fields. They are applied immediately after planting but great care must be taken to minimize adverse effects on the crop. Ametryne has been shown to be relatively safe for the plants and it has a short life in the soil. The most persistent weed is *Cyperus rotundus* L. (nutgrass, yellow nutgrass, purple nutsedge, coqui or coyolillo) which decreases yields and competes with the crop for nitrogen.

In some plantations, a mulch of dry banana leaves is maintained to discourage weeds. Some growers resort to live groundcovers such as *Glycine javanica* L. (Rhodesian kodzu), *Commelina* spp., or *Zebrina pendula* Schnizl. or other creepers, but these tend to climb the banana stems and become a nuisance. Sometimes short-term crops are interplanted in young banana fields, for example, maize, eggplant, peppers, tomatoes, okra, sweetpotato, pineapple or upland rice. A space of at least 0.91 m must be kept clear around each banana plant. However, there are banana authorities who are opposed to interplanting.

Bananas and plantains are heavy feeders. It has been calculated that a harvest of 5 tons of fruit from an acre leaves the soil depleted by 10 kg nitrogen, 1.8 kg phosphorus, 25 kg potash and 312 g

calcium. In general, it can be said that banana plants have high nitrogen and phosphorus requirements and a fertilizer formula of 8:10:8 NPK is usually suitable and normally 1 to 1 1/2 tons/acre (1 1 1/2 MT/ha) may be adequate. One-third of the fertilizer is worked into each planting site when most of the plants appear above ground, one third in a circle about 1 ft (30 cm) out from each plant 2 months later, and one-third at double the distance 2 months after that. Supplementary feedings will depend on signs of deficiencies (often determined by leaf analyses) as the plantation develops. Fertilization needs vary with the soil. In Puerto Rico, most plantains are grown on humid Oxisols and Ultisols in the interior. These soils are well drained but relatively infertile and highly acid, the pH being about 4.8. On such soils, potassium uptake may be too high and N and Mg deficiencies occur. But experts have shown that these soils respond to good fertilization practices and can be very productive. As an example, 224 lbs N per acre (224 kg/ha) applied in circular bands 1.5 ft (0.46 m) from the base of the pseudostem gives a significantly higher yield than broadcast N, and there is good response to Mg applied at time of planting and again 7 months later.

In the humid mountain regions of Puerto Rico, 250 to 325 lbs N per acre (250 325 kg/ha), 125 to 163 lbs phosphorus per acre (125 163 kg/ha), and 500 to 650 lbs potassium per acre (500 650 kg/ha) are recommended for plantains. On lowland sandy clay, phosphorus and magnesium applications appear ineffective. Applications of N at the rate of 168 to 282 lbs/acre (168-282 kg/ha) increase size and number of fruits harvested, but higher rates of N decrease yield because of the number of plants that bend over halfway or are stunted or fail to flower. Applications of 1,121 lbs N per acre (1,121 kg/ha) reduce production by 46%. Potassium at the rate of 405 to 420 lbs/acre (405 420 kg/ha) has the effect of increasing weight and number of fruits. However, there appear to be factors, possibly soil magnesium and calcium, which inhibit the uptake of potassium. One study showed that it took one year for heavy applications of K to reach down to a depth of 20 cm where most of the roots were found in a banana plantation on clay loam. One benefit of added potassium is that it makes bananas more buoyant. In cool, dry seasons in Honduras, the fruit tissue is abnormally dense and there is a high rate of "sinkers" when hands are floated through a washing tank. Such fruits have been found deficient in potassium and increased potassium in the fertilizer has reduced the problem. Irrigation by costly overhead sprinkler systems is standard practice in large scale banana culture in Central America. Without such equipment, irrigation basins may be necessary throughout the field and they should be able to hold at least 7.5 cm of water. During the first 2 months, the plants should be irrigated every 7 to 10 days; older plants need irrigation only every 3 to 4 weeks in dry seasons. On heavy soils, too frequent irrigations decrease yields. For maximum root development, the water table must be between 14 and 19 in (36 to 48 cm) below ground level.

To preserve the original density, the plants are pruned; that is, only the most deep seated sucker and one or more of its offshoots ("peepers") are permitted to exist beside each parent plant to serve as replacements and maintain a steady succession. All other suckers are killed to prevent competition with the pseudostem and its "followers", and a bunch of fruits will be ready for harvest every 6 to 8 months. Various methods of de-suckering have been employed: 1) wrenching by hand; 2) cutting at soil level with a banana knife; 3) cutting at soil level and filling the base with kerosene; 4) cutting at soil level and killing the under ground terminal bud by thrusting in and twisting a gouging tool.

As the older leaves wither and droop, they must be removed because they interfere with spraying, they shade the suckers, cause blemishes on the fruits, harbor disease, insects and other creatures, and constitute a fire hazard.

Bearing bananas require propping. This has been done with simple wooden or bamboo poles, forked poles, or two stakes fastened together to form an "X" at the top, a system much less harmful to the pseudostem. Of the plant may be tied back to pickets driven into the ground, to prevent falling with the weight of the bunch.

Various types of covering—dry banana leaves, canvas, drill cloth, sisal sacks, or burlap or so-called "Hessian" bags (made of jute), have been put over banana bunches intended for export, especially to enhance fruit development in winter and avoid blemishes. In 1955, Queensland led the trend toward adoption of tubular poly vinylchloride (PVC), then the cheaper blue polyethylene covers after trials produced record bunches. At first, the transparent covering caused sunburn on the first two hands and it was found necessary to protect these with newspaper before pulling on the plastic sleeve. The use of plastic covers became standard practice not only in Australia but in Africa, India and the American tropics. In 1963, Queensland growers were turning to covers made of High Wet Strength

(formaldehyde-treated) kraft paper which was already in use for garbage bags. These bags were easily stapled at the top, prevented sunburn, resisted adverse weather, and were reusable for at least another season. Some growers still prefer the burlap. It is cautioned that the cover should not be put on until the bracts have lifted from the fruits (about 21 days after "shooting") so that the young fingers will be firm enough to resist the friction of the cover.

If bunches are composed of more than 7 hands, debudding, or "de-belling" that is, removal of the terminal male bud (which keeps on extending and growing) will result in somewhat fuller bananas, thus increasing bunch weight. The cut should be made several inches below the last hand so that the rotting tip of the severed stalk will not affect the fruits.

Harvesting

Banana bunches are harvested with a curved knife when the fruits are fully developed, that is, 75% mature, the angles are becoming less prominent and the fruits on the upper hands are changing to light green; and the flower remnants (styles) are easily rubbed off the tips. Generally, this stage is reached 75 to 80 days after the opening of the first hand. Cutters must leave attached to the bunch about 15-18 cm of stalk to serve as a handle for carrying. With tall cultivars, the pseudostem must be slashed partway through to cause it to bend and harvesters pull on the leaves to bring the bunch within reach. They must work in pairs to hold and remove the bunch without damaging it. In the early 1960's a "banana bender" was invented in Queensland—an 8-ft pole with a steel rod mounted at the top and shaped with a downward pointing upper hook and an upward-pointing lower hook, the first to pull the pseudostem down after nicking and the second to support the bent pseudostem so that the bunch can be cut at a height of about 1.35 m.

Formerly, entire bunches were transported to shipping points and exported with considerable loss from inevitable damage. Improved handling methods have greatly reduced bunch injuries. In modern plantations, the bunches are first rested on the padded shoulder of a harvester and then are hung on special racks or on cables operated by pulleys by means of which they can be easily conveyed to roads and by vehicle to nearby packing sheds. Where fields have been located in remote areas lacking adequate highways, transport out has been accomplished by hovercraft flying along riverbeds. In Costa Rica, when rains have prevented truck transport to railway terminals, bananas have been successfully carried in slings suspended from helicopters. Exposure to even moderate light after harvest initiates the ripening process. Therefore the fruits should be protected from light as much as possible until they reach the packing shed.

Banana plantations, if managed manually, may survive for 25 years or far longer. The commercial life of a banana "stool" is about 5 or 6 years. From the 4th year on, productivity declines and the field becomes too irregular for mechanical operations. Sanitary regulations require that the old plantings be eradicated. In the past, this has been done by digging out the plants with the mattock, or bringing in cattle to graze on them. In recent years, the old plants and the suckers that arise from the old corms are injected with herbicide until all are thoroughly killed and the field is then cleared. Where bananas or plantains are raised on cleared forest land without sophisticated maintenance practices, they become thoroughly infested with nematodes by the end of the third year and the regrowth of underbrush has begun to take over the field, so it is simply abandoned.

Yield

It is clear that many factors determine the annual yield from a banana or plantain plantation: soil and agronomic practices, the cultivar planted, spacing, the type of propagating material and the management of sucker succession. The 'Gros Michel' banana has yielded 3 to 7 tons per acre (3 to 7 MT/ha) in Central America. A 'Giant Cavendish' bunch may weigh 110 lbs (50 kg) and have a total of 363 marketable fruits. A well-filled bunch of "Dwarf Cavendish" will have no more than 150 to 200 fruits. Sword suckers of plantains have yielded 54,984 fruits per acre (135,866 fruits/ha); water suckers, 49,021 fruits per acre (121,132 fruits/ha).

With heavy fertilization, the 'Maricongo' plantain in Puerto Rico, planted at the rate of 725 per acre has produced 21,950 fruits per acre (54,238 fruits/ha); at the rate of 1,450 per acre has produced 39,080 fruits per acre (96,369 fruits/ha); in a single year.

'Maricongo' plantains spaced at 5 x 5 ft (1.5 x 1.5 m), 1,742 plants/acre (4,303 plants/ha), have produced 33.4 tons per acre (73.5 tons/ha) over a period of 30 months.

Handling and packing

Banana bunches were formerly padded with leaf trash which absorbed much of the sap and latex from the harvesting operation and the sites of broken off styles, each of which can leak at least 6 drops, especially if bunches are cut early in the morning. In the 1960's, when whole bunches were being exported from the Windward Islands and Jamaica to England, they were wrapped in wadding (paperbacked layers of paper tissue) to absorb the latex, and then encased in plastic sleeves for shipment. Nowadays plastic sleeves left on the bunches help protect them during transport from the field to distant packing sheds and a cushion of banana trash on the floor and against the sides of the truck does much to reduce injury. But the plastic bags increase the problem of staining by the sap/latex which mingles with the condensation inside the bag, becomes more fluid, runs down the inside and stains the peel. When hands are cut off, additional sap/latex mixture oozes from the severed crown. Banana growers and handlers know that this substance oxidizes and makes an indelible dark-brown stain on clothing. It similarly blemishes the fruits. At packing stations, the hands are floated through water tanks to wash it off. (Sodium hydrochlorate is an effective solvent.) Some people maintain that the fruit should remain in the tank for 30 minutes until all oozing of latex ceases. At certain times of the year, up to 5% of the hands may sink to the bottom of the tank, become superficially scarred and no longer exportable. As mentioned earlier, increased potassium in fertilizer mixtures renders the bananas more buoyant and fewer hands sink. In rainy seasons, it may be necessary to apply fungicide on the cut crown surface to avoid rotting, though experiments have shown that some fungicides give an off-flavour to the fruit.

Boxing was experimented with in the late 1920's but abandoned because of various types of spoilage. Modern means of combatting the organisms that cause such problems, as well as better systems of handling and transport, quality control, and good container design, have made carton packing not only feasible but necessary. First, the hands are graded for size and quality and then packed in layers in special ventilated cartons with plastic padding to minimize bruising.

In the past, bananas for export from Fiji to New Zealand were detached individually from the hands and packed tightly in 72-lb (33 kg) wooden boxes, with much bruising of the upper layer and of the fruits in contact with the sides. Reduction of fruit quality was found to offset the economic advantage of filling all the shipping space with fruits. Wooden boxes were abandoned and suppliers were converted to the packing of hands with cushioning material.

Controlled ripening and storage

At times, markets may not be able to absorb all the bananas or plantains ready for harvest. Experiments have been conducted to determine the effect of applying gibberellin, either by spraying or in the form of a lanolin paste, on the stalk just above the first hands, or by injection of a solution, powder or tablet into the stalk. In Israel, gibberellin A₄A₇, applied by any of these methods about 2 months before time of normal ripening, had the effect of delaying ripening from 10 to 19 days. If applied too early, the gibberellin treatment has no effect.

Harvested bananas allowed to ripen naturally at room temperature do not become as sweet and flavourful as those ripened artificially. Post harvest ripening is expedited undesirably if bunches or hands are stored in unventilated polyethylene bags. As a substitute for expensive controlled-temperature storage rooms, researchers in Thailand have found that hands treated with fungicide can be stored or shipped over a period of 4 weeks in polyethylene bags if ethylene absorbing vermiculite blocks (treated with a fresh solution of potassium permanganate) are included in the sack. The permanganate solution will be ineffective if exposed to light and oxygen. The blocks must be encased in small polyethylene bags perforated only on one side to avoid staining the fruits.

Bananas are generally ripened in storage rooms with 90 to 95% relative humidity at the outset, later reduced to 85% by ventilation: and at temperatures ranging from 58° to 75°F (14.4°-23.9°C), with 2 to 3 exposures to ethylene gas at 1: 1000, or 6 hourly applications for 1 to 4 days, depending on the speed of ripening desired. The fruit must be kept cool at 56° to 60°F (13.3°-15.6°C) and 80 to 85% relative humidity after removal from storage and during delivery to markets to avoid rapid spoilage.

Post-ripening storage at 70°F (21°C) in air containing 10 to 100 ppm ethylene accelerates softening but the fruits will remain clear yellow and attractive with few or no superficial brown specks.

Plantains for processing in the ripe stage or marketing fresh must be stored under conditions that will provide the best quality of finished product. Puerto Rican studies have shown that uniform ripening is achieved in 4 to 5 days by storage at 56° to 72°F (13.3°-22.2°C), 95 to 100% relative humidity, and with a single exposure to ethylene gas. The initial 4% starch content is reduced to 1 to 1.74% and sugars increase by about 2%. The ripe fruit can be held another 6 days at 56°F (13.3°C) and still be acceptable for processing.

The manufacture of products from the green, still starchy, plantain is a major industry in Puerto Rico. If held at room temperature, the fruits begin to ripen 7 days after harvest and become fully ripe at the end of 2 more days. Chemically disinfected fruits stored in polyethylene bags with an ethylene absorbent (Purefil wrapped in porous paper) keep 25 days at room temperature of 85°F (29.44°C), and for 55 days under refrigeration at 55°F (12.78°C). Products of such fruits have been found to be as good as or better than those made from freshly harvested green plantains.

The potential benefits of waxing have been considered by various investigators. While it is true that waxing of pre-disinfected fruits prolongs storage life by 60% at room temperature, 78°-92°F (25.56°-33.33°C), and by 28% at 52° to 55°F (11.11°-12.78°C), there is no advantage in waxing if the fruits can be held in gas storage, a combination of waxing and gassing being no better than gassing alone. In fact, waxing may result in uneven ripening after storage.

In the mid 1960's, fumigation by ethylene dibromide (EDB) against fruit fly infestation was authorized to permit export of Hawaiian bananas to the mainland USA. The treatment accelerated ripening and it could not be applied to 'Dwarf Cavendish' without covering the bunch with opaque or semi-opaque material for at least 2 months prior to harvest. EDB is no longer approved for use on food products for marketing within the United States.

Pests

Wherever bananas and plantains are grown, nematodes are a major problem. In Queensland, bananas are attacked by various nematodes that cause rotting of the corms: spiral nematodes—*Scutellonema brachyurum*, *Helicotylenchus multicinctus* and *H. nannus*; banana root-lesion nematode, *Pratylenchus coffaea*, syn. *P. musicola*; and the burrowing nematode, *Radopholus similis* less than 1 mm long, which enters roots and corms, causing red, purple and reddish-black discoloration and providing entry for the fungus *Fusarium oxysporum*. And also prevalent is the root-knot nematode, *Meloidogyne javanica*.

Plantains in Puerto Rico are attacked by 22 species of nematodes. The most injurious is the burrowing nematode and it is the cause of the common black headtoppling disease on land where plantains have been cultivated for a long time. Wherever coffee has been grown, *Pratylenchus coffaea* is the principal nematode, and where plantains have been installed on former sugar cane land, *Meloidogyne incognita* is dominant. These last two are among the three most troublesome nematodes of Surinam, the third being *Helicotylenchus* spp., especially *H. multicinctus*.

Nematicides, properly applied, will protect the crop. Otherwise, the soil must be cleared, plowed and exposed to the sun for a time before planting. Sun destroys nematodes at least in the upper several inches of earth. Some fields may be left fallow for as long as 3 years. Rotating plantains with Pangola grass (*Digitaria decumbens*) controls most of the most important species of nematodes except *Pratylenchus coffaea*. All planting material must be disinfected—corms, or parts of corms, or the bases of suckers. There are various means of accomplishing this. In Hawaii, corms are immersed in water at 122°F (50°C) for 15 minutes and soaked for 5 minutes in 1% sodium hypochlorite. In Puerto Rico, nematodes are combated by immersing plantain corms in a solution of Nemagon for 5 minutes about 24 hours before planting and, when planting, mixing the soil in the hole with granular Dasanit (Fensulfthion) and every 6 months applying Dasanit in a ring around the pseudostem.

In Queensland, corms are immersed in hot water-131°F (55°C)—for 20 minutes or solutions of nonvolatile Nemacur or Mocap. Hot water and Nemacur are equally effective but hot water has less adverse effects on plant vigor. The Australians believe that nematicidal treatment of corms must be

preceded by peeling off 3/8 in (1 cm) of the outer layer (usually discolored) even though this diminishes the vigor of the planting material. However, tests with 'Maricongo' plantain corms in Puerto Rico indicate that immersing for 10 minutes in aqueous solutions of Carbofuran, Dasanit, Ethoprop, or Phenamiphos without the time consuming and possibly detrimental peeling reduces the initial nematode populations by about 95 % and all the nematicides except Carbofuran give adequate post-planting control. Carbofuran apparently does not penetrate deeply enough. The Florida spiral nematode is the most damaging nematode in Brazil and Florida, especially during hot, rainy summers. Ethoprop is the only nematicide registered for use on bananas in Florida but it is not effective against this pest. The hot water treatment must be employed.

The black weevil, *Cosmopolites sordidus*, also called banana stalk borer, banana weevil borer, or corm weevil, is the second most destructive pest of bananas and plantains. It attacks the base of the pseudostem and tunnels upward. A jelly like sap oozes from the point of entry. It was formerly controlled by Aldrin, which is now banned. In Surinam it has been combatted by injecting pesticide into the pseudostem, or spraying the pseudostem with Monocrotophos. In Ghana, they dip planting material in a solution of Monocrotophos and apply dust of Dieldrin or Heptachlor around the base of the pseudostem. Puerto Rican tests of several pesticides have shown that Aldicarb 10G, a nematicide insecticide, applied at the base of plantain plants at the rate of 1 to 1 1/2 oz (30-45 g) every 4 months, or 1 oz (30 g) every 6 months, controls both the burrowing nematode and the black weevil. Biological control of black weevil utilizing a weevil predator, *Piaesius javanus*, has not been successful.

The banana rust thrips, *Chaetanophothrips orchidii*; syn. *C. signipennis*, stains the peel, causes it to split and expose the flesh which quickly discolors. The pest is usually partially controlled by the spraying of Dieldrin around the base of the pseudostem to combat the banana weevil borer, because it pupates in the soil. Another measure has been to treat the inside of polyethylene bunch covers with insecticidal dust, especially Diazinon, before slipping them over the bunches. It is recognized that this procedure constitutes a health hazard to the workers. A great improvement is the introduction of polyethylene bags impregnated with 1% of the insecticide Dursban, eliminating the need for dusting. Bunches enclosed in these bags have been found 85% free of attack by the banana rust thrips. The bags retain their potency for at least a year in storage. Impregnated with 1 to 2% Dursban, they are equal to Diazinon in preventing banana injury by the banana fruit scarring beetle, *Colaspis hypochlora*, also called coquito. This pest invades the bunches when the fruits are very young. It has been very troublesome in Venezuela, and at times from Guyana to Mexico. The banana scab moth, *Nacoleia octasema*, infests the inflorescence from emergence to the time half the bracts have lifted. It is a major pest in North Queensland, Malaysia and the southwest Pacific. Control may be by injection or dusting with pesticide, sometimes with lifting or removal of bracts. Corky scab of bananas in southern Queensland is caused by the banana flowers thrips, *Thrips florum*, especially in hot, dry weather. The infestation is lessened by removal of the terminal male bud which tends to harbor the pest.

Among minor enemies in Queensland is the banana spider mite, *Tetranychus lambi* which moves from beneath the leaves to the fruits in warm weather and creates dull brown specks which may become so numerous as to completely cover the peel, causing it to dehydrate and crack irregularly. The leaves of the plant will wilt. Bi-weekly sprayings of pesticide get rid of the mites.

The banana silvering thrips, *Hercinothrips bicintus*, causes silvery patches on the peel and dots them with shiny black specks of excrement. The rind-chewing caterpillar, *Barnardiella sciaphila*, usually does little damage. Two species of fruit fly—*Strumeta tryoni* and *S. musae*—occasionally attack bananas in North Queensland.

Diseases

It is appropriate here only to mention the main details of those maladies which are of the greatest concern to banana and plantain growers. Sigatoka, or leaf spot, caused by the fungus *Mycosphaerella musicola* (of which the conidial stage is *Cercospora musae*) was first reported in Java in 1902, next in Fiji in 1913 where it was named after the Sigatoka Valley. It appeared in Queensland 10 years later, and in another 10 years made its appearance in the West Indies and soon spread throughout tropical America. The disease was noticed in East and West Tropical Africa in 1939 and 1940. It was discovered in Ghana in 1954 and ravaged a state farm in 1965. It is most prevalent on shallow, poorly drained soil and in areas where there is heavy dew. The first signs on the leaves are

small, pale spots which enlarge to 1.25 cm, become dark purplish black and have gray centers. When the entire plant is affected, it appears as though burned, the bunches will be of poor quality and will not mature uniformly. The fruits will be acid, the plant roots small. Control is achieved by spraying with orchard mineral oil, usually every 3 weeks, a total of 12 applications of 1 1/2 gals per acre (14.84 liters/ha); or by systemic fungicides applied to the soil or by aerial spraying.

A much more virulent malady, Black Sigatoka, or Black Leaf Streak, caused by *Mycosphaerella fijiensis* var. *difformis*, attacked bananas in Honduras in 1969 and spread to banana plantations in Guatemala and Belize. It appeared in plantations in Honduras in 1972 where there had not been any need to spray against ordinary Sigatoka. It made headway rapidly through plantain fields in Central America to Mexico and about 10 years later was found in the Uruba region of Colombia. The disease struck Fiji in 1963 and became an epidemic. It began spreading in 1973, largely replacing ordinary Sigatoka. Surveys have revealed this previously unrecognized disease on several other South Pacific islands, in Hawaii, the Philippines, Malaysia and Taiwan. It is spread mostly by wind; kills the leaves and exposes the bunches to the sun. Cultivars which are resistant to Sigatoka have shown no resistance to Black Sigatoka. There are vigorous efforts to control the disease by fungicides or intense oil spraying. But it is not completely controlled even by spraying every 10 to 12 days a total of 40 sprayings. The cost of control with fungicides is 3 to 4 times that of controlling ordinary Sigatoka because of the need for more frequent aerial sprayings. It is very difficult to treat properly on islands where bananas are grown mostly in scattered plantings. In Mexico where plantains are extremely important in the diet, and 65% of the production is on non-irrigated land, control efforts have elevated costs of plantain production by 145 to 168%. In the Sula Valley of Honduras, Black Sigatoka has caused annual losses of 3,000,000 boxes of bananas. The great need is for resistant cultivars of high quality.

Panama Disease or Banana Wilt, which arises from infection by the fungus, *Fusarium oxysporum* f. sp. *cubense* originates in the soil, travels to the secondary roots, enters the corm only through fresh injuries, passes into the pseudostem; then, beginning with the oldest leaves, turns them yellow first at the base, secondly along the margins, and lastly in the center. The interior leaves turn bronze and droop. The pseudostem turns brown inside. This plague has seriously affected banana production in Central America, Colombia and the Canary Islands. It started spreading in southern Taiwan in 1967 and has become the leading local banana disease. The 'Cavendish' types have been considered highly resistant but they succumb if planted on land previously occupied by 'Gros Michel'. The disease is transmitted by soil, moving agricultural vehicles or other machinery, flowing water, or by wind. It is combatted by flooding the field for 6 months. Or, if it is not too serious, by planting a cover crop. There are reportedly two races: Race #1 affects 'Gros Michel', 'Manzano', 'Sugar' and 'Lady Finger'; Race #2 attacks 'Bluggoe'. Resistant cultivars are the Jamaican 'Lacatan', 'Monte Cristo', and 'Datil' or 'Nino'. Resistant plantains are 'Maricongo', 'Enano' and 'Pelipita'.

Moko Disease, or Moko de Guineo, or Marchites bacteriana, is caused by the bacterium, *Pseudomonas solanacearum*, resulting in internal decay. It has become one of the chief diseases of banana and plantain in the western hemisphere and has seriously reduced production in the leading areas of Colombia. It attacks *Heliconia* species as well. It is transmitted by insects, machetes and other tools, plant residues, soil, and root contact with the roots of sick plants. There are said to be 4 different types transmitted by different means. Efforts at control include covering the male bud with plastic to prevent insects from visiting its mucilaginous excretion; debudding, disinfecting of cutting tools with formaldehyde in water 1: 3; disinfection of planting material; disposal of infected fruits and plant parts; injection of herbicide into infected plants to hasten dehydration, and also seemingly healthy neighboring plants. If the organism is variant SFR, all adjacent plants within a radius of 16.5 ft (5 m) must be destroyed and the area not replanted for 10 to 12 months, for this variant persists in the soil that long. If it is variant B, the plants within 32.8 ft (10 m) must be injected and the area not replanted for 18 months. In either case, the soil must be kept clear of broad leaved weeds that may serve as hosts. In Colombia, there are 12 species of weeds that serve as hosts or "carriers" but only 4 of these are themselves susceptible to the disease. Crop rotation is sometimes resorted to. The only sure defense is to plant resistant cultivars, such as the 'Pelipita' plantain.

Black-end arises from infection by the fungus *Gloeosporium musarum*, of which *Glomerella cingulata* is the perfect form. It causes anthracnose on the plant and attacks the stalk and stalk-end of the fruits forming dark, sunken lesions on the peel, soon penetrating the flesh and developing dark, watery, soft areas. In severe cases, the entire skin turns black and the flesh rots. Very young fruits shrivel and

mummify. This fungus is often responsible for the rotting of bananas in storage. Immersing the green fruits in hot water, 131°F (55°C) for 2 minutes before ripening greatly reduces spoilage.

Cigar-tip rot, or Cigar-end disease, *Stachyldium* (*Verticillium*) *theobromae* begins in the flowers and extends to the tips of the fruits and turns them dark, the peel darkens, the flesh becomes fibrous. One remedy is to cut off withered flowers as soon as the fruits are formed and apply copper fungicides to the cut surfaces.

In Surinam, cucumber mosaic virus attacks plantains especially when cucumber is interplanted in the fields. Also, Chinese cabbage, Cayenne pepper and "bitter greens" (*Cestrum latifolium* Lam.) are hosts for the disease.

Cordana leaf spot (*Cordana musae*), causes oval lesions 3 in (7.5 cm) or more in length, brown with a bright-yellow border. There is progressive dying of the leaves beginning with the oldest, as in Sigatoka, with consequent undersized fruits ripening prematurely. It formerly occurred mainly in sheltered, humid regions of Queensland. Now it is seen mostly as an invader of areas affected by Sigatoka, in various geographical locations.

Bunchy top, an aphid-transmitted virus disease of banana, was unknown in Queensland until about 1913 when it was accidentally introduced in suckers brought in from abroad. In the next 10 years it spread swiftly and threatened to wipe out the banana industry. Drastic measures were taken to destroy affected plants and to protect uninvaded plantations. The disease was found in Western Samoa in 1955 and it eliminated the susceptible 'Dwarf Cavendish' from commercial plantings. A vigorous eradication and quarantine program was undertaken in 1956 and carried on to 1960. Thereafter, strict inspection and control measures continued. Other crops were provided to farmers in heavily infested areas. Leaves formed after infection are narrow, short, with upturned margins and become stiff and brittle; the leafstalks are short and unbending and remain erect, giving a "rosetted" appearance. The leaves of suckers and the 3 youngest leaves of the mother plant show yellowing and waviness of margins, and the youngest leaves will have very narrow, dark-green, usually interrupted ("dot-and dash") lines on the underside.

Because of the seriousness of Panama disease and Bunchy Top in southern Queensland, the prospective banana planter must obtain a permit from the Queensland Department of Primary Industries. In the Southern Quarantine Area, any plant showing Bunchy Top, as well as its suckers and all plants within a 15 ft (4.6 m) radius must be killed by injecting herbicide or must be dug out completely and cut into pieces no bigger than 2 in (5 cm) wide. In restricted areas, only the immune 'Lady Finger' may be grown. In the Northern Quarantine Area, no plants may be brought in from another area and all plants within a radius of 120 ft (36.5 m) from a diseased plant must be eradicated.

Swelling and splitting of the corm and the base of the pseudostem is caused by saline irrigation water and by overfertilization during periods of drought which builds up soluble salts in the soil.

Food uses

The ripe banana is utilized in a multitude of ways in the human diet—from simply being peeled and eaten out of-hand to being sliced and served in fruit cups and salads, sandwiches, custards and gelatins; being mashed and incorporated into ice cream, bread, muffins, and cream pies. Ripe bananas are often sliced lengthwise, baked or broiled, and served (perhaps with a garnish of brown sugar or chopped peanuts) as an accompaniment for ham or other meats. Ripe bananas may be thinly sliced and cooked with lemon juice and sugar to make jam or sauce, stirring frequently during 20 or 30 minutes until the mixture jells. Whole, peeled bananas can be spiced by adding them to a mixture of vinegar, sugar, cloves and cinnamon which has boiled long enough to become thick, and then letting them cook for 2 minutes.

In the islands of the South Pacific, unpeeled or peeled, unripe bananas are baked whole on hot stones, or the peeled fruit may be grated or sliced, wrapped, with or without the addition of coconut cream, in banana leaves, and baked in ovens. Ripe bananas are mashed, mixed with coconut cream, scented with *Citrus* leaves, and served as a thick, fragrant beverage.

Banana puree is important as infant food and can be successfully canned by the addition of ascorbic acid to prevent discoloration. The puree is produced on a commercial scale in factories close to banana fields and packed in plastic-lined #10 cans and 55-gallon metal drums for use in baby foods, cake, pie, ice cream, cheesecake, doughnuts, milk shakes and many other products. It is also used for canning half-and-half with applesauce, and is combined with peanut butter as a spread. Banana nectar is prepared from banana puree in which a cellulose gum stabilizer is added. It is homogenized, pasteurized and canned, with or without enrichment with ascorbic acid.

Sliced ripe bananas, canned in sirup, were introduced to the food trade for commercial use in frozen tarts, pies, gelatins and other products. In 1966, the United Fruit Company built a processing plant at La Lima, Honduras, for producing canned and frozen banana puree and canned banana slices. Because of seasonal gluts and perishability and the tonnages of bananas and plantains that are not suitable for marketing or export because of overripeness or stained peel or other defects, there is tremendous interest in the development of modes of processing and preserving these fruits.

In Polynesia, there is a traditional method of preserving large quantities of bananas for years as emergency fare in case of famine. A pit is dug in the ground and lined with banana and *Heliconza* leaves. The peeled bananas are wrapped in *Heliconza* leaves, arranged in layer after layer, then banana leaves are placed on top and soil and rocks heaped over all. The pits remain unopened until the fermented food, called "masi", is needed.

In Costa Rica, ripe bananas from an entire bunch are peeled and boiled slowly for hours to make a thick sirup which is called "honey".

Green bananas, boiled in the skin, are very popular in Cuba, Puerto Rico and other Caribbean islands. In Puerto Rico, the cooked bananas are recooked briefly in a marinating sauce containing black pepper, vinegar, garlic, onions, bay leaves, olive oil and salt and left standing at room temperature for 24 hours before being eaten. Peeled, sliced green bananas are quick-frozen in Puerto Rico for later cooking. If steam treated to facilitate peeling, the enzymes are inactivated only on the surface of the flesh and the interior, when exposed, will turn brown unless sulfited. It is more satisfactory to immerse the whole bananas in water at 200°F (93°C) for 30 minutes which wholly inactivates the enzymes. No sulfite is then needed and no browning occurs.

Much research has been conducted by food technologists at the University of Puerto Rico to determine the best procedures for canning sliced green bananas and plantains to make them readily available for cooking. Enzyme inactivation is necessary and the hot water treatment facilitates the peeling. If peeled raw, green bananas and plantains exude gummy white latex which stains materials. When canning, citric acid in a 2% brine is added, but this method of preservation has not yet met with success because of rapid detinning of the inside of the cans. The problem is not solved by using enamellined cans because the fruit darkens quickly after the cans are opened. Glass jars may prove to be the only suitable containers.

Through experimental work with a view to freezing peeled, blanched, sliced green bananas, it has been found that, with a pulp-to-peel ratio of less than 1:3 the fruits turn gray on exposure to air after processing and this discoloration is believed to be caused by the high iron content (4.28 p/m) of the surface layer of the flesh and its reaction to the tannin normally present in green bananas and plantains. At pulp to peel ratio of 1:0, the tannin level in green bananas is 241.4 mg; at 1:3, 151.0 mg, and at 1:5, 112.6 mg, per 100 g. Therefore, it is recommended that for freezing green bananas be harvested at a stage of maturity evidenced by 1:5 pulp-to-peel ratio. Such fruits have a slightly yellowish flesh, higher carotene content, and are free of off-flavours. The slices are cooked by the consumer without thawing.

Completely green plantains are 50% flesh and 50% peel. Plantains for freezing should have a pulp content of at least 60% for maximum quality in the ultimate food product, but a range of 55 to 65% is considered commercially acceptable.

Ripe plantains, held until the skin has turned mostly or wholly black, are commonly peeled, sliced diagonally and fried in olive oil, accompany the main meal daily in the majority of homes in tropical Latin America. In the Dominican Republic, a main dish is made of boiled, mashed ripe plantains mixed with beaten eggs, flour, butter, milk and cloves, and layered in a casserole with ground beef

fried with Picalilli and raisins, lastly topped with grated cheese and baked until golden brown. In Guatemala, boiled plantains are usually served with honey.

Green plantains are popular sliced crosswise, fried until partially cooked, pressed into a thickness of 1/2 in (1.25 cm), and fried in deep fat till crisp. The product is called 'tostones' and somewhat resembles French-fried potatoes. Puerto Rican "mofongo" is a ball of fried green plantain mashed with fried pork rind, seasoned with thickened stock, garlic and other condiments. It must be eaten hot before it hardens. "Mofongo" has been successfully frozen in boilable pouches. Slices of nearly ripe plantain (5% starch content) are cooked in syrup and frozen in boilable pouches. Puerto Rican plantains, shipped green to Florida, have been ripened, peeled, quartered, infused with orange juice, frozen and provided to schools for serving as luncheon dessert.

In Ghana, plantains are consumed at 5 different stages of ripeness. Fully ripe plantains are often deep fried or cooked in various dishes. A Ghanaian pancake called "fatale" is made of nearly full ripe plantains and fermented whole meal dough of maize, seasoned with onions, ginger, pepper and salt, and fried in palm oil. "Kaklo" is the same mix but thicker and rolled into balls which are deep-fried. Because home preparation is laborious, a commercial dehydrated mix has been developed. In Ghana, green plantains are boiled and eaten in stew or mashed, together with boiled cassava, into a popular plastic product called "fufu" which is eaten with soup. Because of the great surplus of plantains in summer, technologists have developed methods for drying and storing of strips and cubes of plantain for house use in making "fufu" out of season. The cubes can also be ground into plantain flour. Use of infrared, microwave, and extrusion systems has resulted in high-quality finished products. Processing has the added advantage of keeping the peels at factories where they may be converted into useful by-products instead of their adding to the bulk of household garbage.

Banana or plantain flour, or powder, is made domestically by sun-drying slices of unripe fruits and pulverizing. Commercially, it is produced by spray-drying, or drum-drying, the mashed fruits. The flour can be mixed 50-50 with wheat flour for making cupcakes. Two popular Puerto Rican foods are "pasteles" and "alcapurias"; both are pastry stuffed with meat; the first is wrapped in plantain leaves and boiled; the latter is fried. The pastry is made of plantain flour or a mixture of plantain with cassava (*Manihot esculenta* Crantz.) or cocoyam (taniar), *Xanthosoma* spp. The plantain cultivars 'Saba', 'Tundoc' and 'Latundan' are very suitable for making flour.

Commercial production and marketing of fried green plantain and banana chips has been increasing in various parts of the world over the past 25 years and these products are commonly found in retail groceries alongside potato chips and other snack foods. 'Carinosa' and 'Bungulan' bananas are favored for chip-making. In Puerto Rico, the plantain cultivars 'Guayamero Alto' and 'Congo Enano' are chosen for this purpose.

Dried bananas, or so-called "banana figs" are peeled firm-ripe bananas split lengthwise, sulphured, and oven-dried to a moisture content of 18 to 20%. Wrapped individually in plastic and then packed by the dozen in polyethylene bags, and encased in cartons, they can be stored for a year at room temperature—24° to 30°C and they are commonly exported. The product can be eaten as a snack or minced and used together with candied lemon peel in fruit cake and other bakery products. In India the 'Dwarf Cavendish' is preferred for drying; in the Philippines, the true 'Lacatan' or the 'Higo'.

Canadian researchers have developed a system of osmotic dehydration for sliced firm ripe bananas and plantains, especially designed for developing countries with plentiful sugar for the solutions required.

Since the early 1960's, Brazil has produced dehydrated banana flakes for local markets and export to the USA and elsewhere in vacuum sealed cans. The flakes are used on cereal, in baked goods, canapes, meat loaf and curries, desserts, sauces, and other products. In Israel, banana flakes have been made by steam blanching 'Dwarf Cavendish' bananas and drum drying to 2.6% moisture. The flakes, packed in vacuum sealed cans, keep for a year at 24° to 30°C. At temperatures to 35°C, the flakes darken somewhat and tend to stick together. Israel has also introduced a formula for high-protein flakes made of 70% banana and 30% soybean protein and this development has been adopted in Brazil. The flakes are used by Brazilian food manufacturers in ice cream, and as fillings for cakes and other bakery products. South Africa has produced flakes of 2/3 banana and 1/3 maize meal.

In Africa, ripe bananas are made into beer and wine. The Tropical Products Institute in London has established a simple procedure for preparing an acceptable vinegar from fermented banana rejects.

The terminal male bud of the wild banana, *M. balbisiana*, is marketed in Southeast Asia. It is often boiled whole after soaking an hour in salt water, or with several changes of water to reduce astringency, and eaten as a vegetable. The male bud of cultivated bananas is considered too astringent but it is, nevertheless, sometimes similarly consumed. The flowers may be removed from the bud and prepared separately. They are used in curries in Malaya and eaten with palm oil in West Tropical Africa.

The new shoots of young plants may be cooked as greens. Banana pseudostem core constitutes about 10 to 15% of the whole and contains 1% starch, 0.68% crude fiber and 1% total ash. It is often cooked and eaten as a vegetable in India and is canned with potatoes and tomatoes in a curry sauce. Circular slices about 1/2 in (1.25 cm) thick are treated with citric acid and potassium metabisulphite and candied.

In India, a solution of the ash from burned leaves and pseudostems is used as salt in seasoning vegetable curries. The ash contains roughly (per 100 g): potassium, 255 mg; magnesium, 27 mg; phosphorus, 33 mg; calcium, 6.6 mg; sodium, 51 mg.

Dried green plantains, ground fine and roasted, have been used as a substitute for coffee.

Animal Feed

Reject ripe bananas, supplemented with protein, vitamins and minerals, are commonly fed to swine. Green bananas are also used for fattening hogs but, because of the dryness and astringency and bitter taste due to the tannin content, these animals do not care for them unless they are cooked, which makes the feeding costs too high for most growers. Therefore, dehydrated green banana meal has been developed and, though not equal to grain, can constitute up to 75% of the normal hog diet, 40% of the diet of gestating sows. It is not recommended for lactating sows, nor are ripe bananas, even with a 40% protein supplement.

Beef cattle are very fond of green bananas whether they are whole, chopped or sliced. Because of the fruit's deficiency in protein, urea is added at the rate of 8.8 lbs (4 kg) per ton, with a little molasses mixed in to mask the flavor. But transportation is expensive unless the cattle ranch is located near the banana fields. A minor disadvantage is that the bananas are somewhat laxative and the cattle need to be washed down daily. With dairy cattle, it is recommended that bananas constitute no more than 20% of the feed.

In the Philippines, it has been found that meal made from dehydrated reject bananas can form 14% of total broiler rations without adverse effects. Meal made from green and ripe plantain peels has been experimentally fed to chicks in Nigeria. A flour from unpeeled plantains, developed for human consumption, was fed to chicks in a mixture of 2/3 flour and 1/3 commercial chickfeed and the birds were maintained until they reached the size of fryers. They were found thinner and lighter than those on 100% chickfeed and the gizzard lining peeled in shreds. It was assumed that these effects were the result of protein deficiency in the plantains, but they were more likely the result of the tannin content of the flour which interferes with the utilization of protein.

Leaves, pseudostems, fruit stalks and peels, after chopping, fermentation, and drying, yield a meal somewhat more nutritious than alfalfa presscake. This waste material has been considered for use as organic fertilizer in Somalia. In Malaya, pigs fed the pseudostems are less prone to liver and kidney parasites than those on other diets.

Banana peel contains beta sitosterol, stigmasterol, campesterol, cycloeucaenol, cycloartanol, and 24-methylene cycloartanol. The major constituents are 24-methylene cycloartanol palmitate and an unidentified triterpene ketone.

Food value per 100 g of edible portion*

| | Banana | | | | Plantain | | | |
|---------------|---------------|-------|------------|---------------|--------------|---------------|--------------|---------------|
| | Ripe | Green | Dried | Flour (green) | Ripe | Ripe (cooked) | Green | Dried (green) |
| Calories | 65.5-111 | 108 | 298 | 340 | 110.7-156.3 | 77 | 90.5-145.9 | 359 |
| Moisture | 68.6-78.1g | 72.4g | 19.5-27.7g | 11.2-13.5g | 52.9-77.6g | 79.8g | 58.7-74.1g | 9.0g |
| Protein | 1.1-1.87g | 1.1g | 2.8-3.5g | 3.8-4.1g | 0.8-1.6g | 1.3g | 1.16-1.47g | 3.3g |
| Fat | 0.016-0.4g | 0.3g | 0.8-1.1g | 0.9-1.0g | 0.1-0.78g | 0.10g | 0.10-0.12g | 1.4g |
| Carbohydrates | 19.33-25.8g | 25.3g | 69.9g | 79.6g | 25.50-36.81g | 18.1g | 23.4-37.61g | 83.9g |
| Fiber | 0.33-1.07g | 1.0g | 2.1-3.0g | 3.2-4.5g | 0.30-0.42g | 0.2g | 0.40-0.48g | 1.0g |
| Ash | 0.60-1.48g | 0.9g | 2.1-2.8g | 3.1g | 0.63-1.40g | 0.7g | 0.63-0.83g | 2.4g |
| Calcium | 3.2-13.8mg | 11mg | | 30-39mg | 5.0-14.2mg | | 10.01-12.2mg | 50mg |
| Phosphorus | 16.3-50.4mg | 28mg | | 93-94mg | 21.0-51.4mg | | 32.5-43.2mg | 65mg |
| Iron | 0.4-1.50mg | 0.9mg | | 2.6-2.7mg | 0.40-0.11mg | | 0.56-0.87mg | 1.1mg |
| B-Carotene | 0.006-0.151mg | | | | 0.11-1.32mg | | 0.06-1.38mg | 45mg |
| Thiamine | 0.04-0.54mg | | | | 0.04-0.11mg | | 0.06-0.09mg | 0.10mg |
| Riboflavin | 0.05-0.067mg | | | | 0.04-0.05mg | | 0.04-0.05mg | 0.16mg |
| Niacin | 0.60-1.05mg | | | | 0.48-0.70mg | | 0.32-0.55mg | 1.9mg |
| Ascorbic Acid | 5.60-36.4mg | | | | 18-31.2mg | | 22.2-33.8mg | 1mg |
| Tryptophan | 17-19mg | | | | 8-15mg | | 7-10mg | 14mg |
| Methionine | 7-10mg | | | | 4-8mg | | 3-8mg | |
| Lysine | 58-76mg | | | | 34-60mg | | 37-56mg | |

*Derived from various analyses made in Cuba, Central America and Africa.

Other Uses

Banana leaves are widely used as plates and for lining cooking pits and for wrapping food for cooking or storage. A section of leaf often serves as an eye-shade. In Latin America, it is a common practice during rains to hold a banana leaf by the petiole, upside-down, over one's back as an "umbrella" or "raincoat". The leaves of the 'Fehi' banana are used for thatching, packing, and cigarette wrappers. The pseudostems have been fastened together as rafts.

Split lengthwise, they serve as padding on banana inspection turntables and as cushioning to protect the bunches ("stems") during transport in railway cars and trucks. Seat pads for benches are made of strips of dried banana pseudostems in Ecuador. In West Africa, fibre from the pseudostem is valued for fishing lines. In the Philippines, it is woven into a thin, transparent fabric called "agna" which is the principal material in some regions for women's blouses and men's shirts. It is also used for making handkerchiefs. In Ceylon, it is fashioned into soles for inexpensive shoes and used for floor coverings.

Plantain fibre is said to be superior to that from bananas. In the mid-19th Century, there was quite an active banana fibre industry in Jamaica. Improved processes have made it possible to utilize banana fibre for many purposes such as rope, table mats and handbags. In Kerala, India, a kraft type paper of good strength has been made from crushed, washed and dried banana pseudostems which yield 48 to 51% of unbleached pulp. A good quality paper is made by combining banana fiber with that of the betel nut husk (*Areca catechu* L.). But Australian investigators hold that the yield of banana fibre is too low for extraction to be economical. Only 1 to 4 oz (28-113 g) can be obtained from 40 to 80 lbs (18-36 kg) of green pseudostems; 132 tons of green pseudostems would yield only 1 ton of paper. Their conclusion is that the pseudostem has much greater value as organic matter chopped and left in the field.

Dried banana peel, because of its 30 to 40% tannin content, is used to blacken leather. The ash from the dried peel of bananas and plantains is rich in potash and used for making soap. That of the burned peel of unripe fruits of certain varieties is used for dyeing.

In the Philippines, the Pinatubo Negritos cut off a banana plant close to the ground, make a hollow in the top of the stump, which then fills with watery sap drunk as an emergency thirst quencher. Central Americans obtain the sap of the red banana in the same manner and take it as an aphrodisiac.

Medicinal uses: All parts of the banana plant have medicinal applications: the flowers in bronchitis and dysentery and on ulcers; cooked flowers are given to diabetics; the astringent plant sap in cases of hysteria, epilepsy, leprosy, fevers, haemorrhages, acute dysentery and diarrhoea, and it is applied on haemorrhoids, insect and other stings and bites; young leaves are placed as poultices on burns and other skin afflictions; the astringent ashes of the unripe peel and of the leaves are taken in dysentery and diarrhoea and used for treating malignant ulcers; the roots are administered in digestive disorders, dysentery and other ailments; banana seed mucilage is given in cases of catarrh and diarrhoea in India.

Antifungal and antibiotic principles are found in the peel and pulp of fully ripe bananas. The antibiotic acts against *Mycobacteria*. A fungicide in the peel and pulp of green fruits is active against a fungus disease of tomato plants. Norepinephrine, dopamine, and serotonin are also present in the ripe peel and pulp. The first two elevate blood pressure; serotonin inhibits gastric secretion and stimulates the smooth muscle of the intestines.

Folklore

The banana plant because of its continuous reproduction is regarded by Hindus as a symbol of fertility and prosperity, and the leaves and fruits are deposited on doorsteps of houses where marriages are taking place. A banana plant is often installed in the corner of a rice field as a protective charm. Malay women bathe with a decoction of banana leaves for 15 days after childbirth. Early Hawaiians used a young plant as a truce flag in wars.

Annex E (informative)

Banana — Codex, EU and USA pesticide residue limits

Users are advised that international regulations and permissible Maximum Residue Levels (MRL) frequently change. Although this International MRL Database is updated frequently, the information in it may not be completely up-to-date or error free. Additionally, commodity nomenclature and residue definitions vary between countries, and country policies regarding deferral to international standards are not always transparent. This database is intended to be an initial reference source only, and users must verify any information obtained from it with knowledgeable parties in the market of interest prior to the sale or shipment of any products. The developers of this database are not liable for any damages, in whole or in part, caused by or arising in any way from user's use of the database.

Results Key

MRL values in *{Italics}* are more restrictive than US

--- indicates no MRL value is established.

Cod, EU, etc. indicates the source of the MRL and EXP means the market defers to the exporting market.

All numeric values listed are in parts per million (ppm), unless otherwise noted

| | US | Cod | EU |
|----------------------------|--|---------------|---------------|
| Ametryn | 0.25 | --- | --- |
| | | | |
| | US 1 | Cod | EU |
| Azoxystrobin | 2 | --- | 2 |
| | 1. of which not more than 0.1 is contained in the pulp | | |
| | | | |
| | US | Cod | EU |
| Buprofezin | 0.2 | --- | 0.5 |
| | | | |
| | US | Cod | EU |
| Carbaryl | 5 | --- | <i>{0.05}</i> |
| | | | |
| | US | Cod | EU 2 |
| Carfentrazone-ethyl | 0.2 | --- | <i>{0.01}</i> |
| | 2. European Union does not maintain a specific MRL for the Carfentrazone-ethyl/Banana combination, but does maintain an MRL of 0.01 PPM for its "Fruit Fresh or Frozen; Nuts" group. | | |
| | | | |
| | US 3 | Cod | EU |
| Chlorothalonil | 0.05 | <i>{0.01}</i> | 0.2 |
| | 3. This MRL refers to Banana, edible pulp. | | |
| | | | |
| | US | Cod | EU |
| Chlorpyrifos | 0.1 | 2 | 3 |
| | | | |
| | US | Cod | EU 4 |
| Diquat dibromide | 0.05 | --- | 0.05 |
| | 4. European Union does not maintain a specific MRL for the Diquat dibromide/Banana combination, but does maintain an MRL of 0.05 PPM for its "Fruit Fresh or Frozen; Nuts" group. | | |
| | | | |
| | US | Cod | EU 5 |
| Diuron | 0.1 | --- | 0.1 |
| | 5. European Union does not maintain a specific MRL for the Diuron/Banana combination, but does maintain an MRL of 0.1 PPM for its "Inedible peel, large" group. | | |
| | | | |
| | US | Cod | EU 6 |
| Dodine | 0.5 | --- | <i>{0.2}</i> |
| | 6. European Union does not maintain a specific MRL for the Dodine/Banana combination, but does maintain an MRL of 0.2 PPM for its "Miscellaneous fruit" group. | | |
| | | | |
| | US | Cod | EU |
| Epoxiconazole | 0.5 | --- | 0.5 |

| | US | Cod | EU 7 |
|-----------------------------|--|--------|--------|
| Ethoprop | 0.02 | 0.02 | 0.02 |
| | 7. European Union does not maintain a specific MRL for the Ethoprop/Banana combination, but does maintain an MRL of 0.02 PPM for its "Fruit Fresh or Frozen; Nuts" group. | | |
| | | | |
| | US | Cod | EU |
| Fenbuconazole | 0.3 | {0.05} | {0.05} |
| | | | |
| | US | Cod | EU |
| Fosetyl-Al | 3 | --- | {2} |
| | | | |
| | US 8 | Cod | EU |
| Glufosinate-ammonium | 0.2 | 0.2 | 0.2 |
| | 8. This MRL refers to banana pulp. The US maintains a separate MRL for banana. | | |
| | | | |
| | US | Cod | EU 9 |
| Glyphosate | 0.2 | {0.05} | {0.1} |
| | 9. European Union does not maintain a specific MRL for the Glyphosate/Banana combination, but does maintain an MRL of 0.1 PPM for its "Inedible peel, large" group. | | |
| | | | |
| | US | Cod 10 | EU |
| Imazalil | 3 | {2} | {2} |
| | 10. The MRL accommodates post-harvest treatment of the commodity. | | |
| | | | |
| | US | Cod | EU |
| Imidacloprid | 0.5 | {0.05} | {0.05} |
| | | | |
| | US 11 | Cod 12 | EU |
| Mancozeb | 0.5 | 2 | 2 |
| | 11. This MRL refers to Banana, pulp. The US maintains a separate MRL for Banana. | | |
| | 12. The MRL is established for the sum of dithiocarbamates. | | |
| | | | |
| | US | Cod 13 | EU |
| Maneb | 4 | {2} | {2} |
| | 13. The MRL is established for the sum of dithiocarbamates. | | |
| | | | |
| | US | Cod | EU |
| Myclobutanil | 4 | {2} | {2} |
| | | | |
| | US | Cod | EU 14 |
| Oxamyl | 0.3 | --- | {0.01} |
| | 14. European Union does not maintain a specific MRL for the Oxamyl/Banana combination, but does maintain an MRL of 0.01 PPM for its "Miscellaneous fruit" group. | | |
| | | | |
| | US | Cod | EU 15 |
| Oxyfluorfen | 0.05 | --- | 0.05 |
| | 15. European Union does not maintain a specific MRL for the Oxyfluorfen/Banana combination, but does maintain an MRL of 0.05 PPM for its "Inedible peel, large" group. | | |
| | | | |
| | US | Cod 16 | EU 17 |
| Paraquat dichloride | 0.05 | {0.01} | {0.02} |
| | 16. Codex does not maintain a specific MRL for the Paraquat dichloride/Banana combination, but does maintain an MRL of 0.01 PPM for its "Assorted tropical and sub-tropical fruits - inedible peel" group. | | |
| | 17. European Union does not maintain a specific MRL for the Paraquat dichloride/Banana combination, but does maintain an MRL of 0.02 PPM for its "Fruit Fresh or Frozen; Nuts" group. | | |
| | | | |
| | US | Cod | EU 18 |
| Phosphine | 0.01 | --- | 0.05 |
| | 18. European Union does not maintain a specific MRL for the Phosphine/Banana combination, but does maintain an MRL of 0.05 PPM for its "Fruit Fresh or Frozen; Nuts" group. | | |
| | | | |

| | | | |
|--------------------|--|---------------|--------------|
| | US | Cod | EU |
| Propiconazole | 0.2 | {0.1} | {0.1} |
| | US | Cod | EU |
| Pyraclostrobin | 0.04 | {0.02} | {0.02} |
| | US | Cod | EU |
| Pyrimethanil | 0.1 | 0.1 | 0.1 |
| | US | Cod | EU 19 |
| Pyriproxyfen | 0.2 | --- | {0.05} |
| | 19. European Union does not maintain a specific MRL for the Pyriproxyfen/Banana combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group. | | |
| | US | Cod | EU 20 |
| Spinetoram | 0.25 | --- | {0.05} |
| | 20. European Union does not maintain a specific MRL for the Spinetoram/Banana combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group. | | |
| | US | Cod | EU |
| Spinosad | 0.25 | --- | {0.02} |
| | US | Cod | EU |
| Tebuconazole | 0.05 | 0.05 | 0.05 |
| | US | Cod | EU |
| Terbufos | 0.025 | 0.05 | 0.05 |
| | US | Cod 21 | EU |
| Thiabendazole | 3 | 5 | 5 |
| | 21. The MRL accommodates post-harvest treatment of the commodity. | | |
| | US | Cod | EU |
| Thiophanate-methyl | 2 | --- | {0.1} |

BANANA
Musa species
Musaceae

Common Names: Banana, Bananier Nain, Canbur, Curro, Plantain

Origin: Edible bananas originated in the Indo-Malaysian region reaching to northern Australia.

Species: *Musa acuminata* Colla, *M. X paradisiaca* L. (hybrid)

Related species Abyssinian Banana (*Ensete ventricosum* Cheesman), *Musa balbisina* Colla, *M. ornata* Roxb., *M. textilis* Nee

Adaptation Bananas and plantains are today grown in every humid tropical region and constitutes the 4th largest fruit crop of the world. The plant needs 10 - 15 months of frost-free conditions to produce a flower stalk. All but the hardiest varieties stop growing when the temperature drops below 53° F. Growth of the plant begins to slow down at about 80° F and stop entirely when the temperature reaches 100° F. High temperatures and bright sunlight will also scorch leaves and fruit, although bananas grow best in full sun. Freezing temperatures will kill the foliage. In most areas bananas require wind protection for best appearance and maximum yield. They are also susceptible to being blown over. Bananas, especially dwarf varieties, make good container specimens if given careful attention. The plant will also need periodic repotting as the old plant dies back and new plants develop.

DESCRIPTION

Growth Habit: Bananas are fast-growing herbaceous perennials arising from underground rhizomes. The fleshy stalks or pseudostems formed by upright concentric layers of leaf sheaths constitute the functional trunks. The true stem begins as an underground corm which grows upwards, pushing its way out through the center of the stalk 10-15 months after planting, eventually producing the terminal inflorescence which will later bear the fruit. Each stalk produces one huge flower cluster and then dies. New stalks then grow from the rhizome. Banana plants are extremely decorative, ranking next to palm trees for the tropical feeling they lend to the landscape.

Foliage: The large oblong or elliptic leaf blades are extensions of the sheaths of the pseudostem and are joined to them by fleshy, deeply grooved, short petioles. The leaves unfurl, as the plant grows, at the rate of one per week in warm weather, and extend upward and outward, becoming as much as 9 feet long and 2 feet wide. They may be entirely green, green with maroon splotches, or green on the upper side and red-purple beneath. The leaf veins run from the mid-rib straight to the outer edge of the leaf. Even when the wind shreds the leaf, the veins are still able to function. Approximately 44 leaves will appear before the inflorescence.

Flowers: The banana inflorescence shooting out from the heart in the tip of the stem, is at first a large, long-oval, tapering, purple-clad bud. As it opens, the slim, nectar-rich, tubular, toothed, white flowers appear. They are clustered in whorled double rows along the the floral stalk, each cluster covered by a thick, waxy, hood like bract, purple outside and deep red within. The flowers occupying the first 5 - 15 rows are female. As the rachis of the inflorescence continues to elongate, sterile flowers with abortive male and female parts appear, followed by normal staminate ones with abortive ovaries. The two latter flower types eventually drop in most edible bananas.

Fruits: The ovaries contained in the first (female) flowers grow rapidly, developing parthenocarpically (without pollination) into clusters of fruits, called hands. The number of hands varies with the species and variety. The fruit (technically a berry) turns from deep green to yellow or red, and may range from 2-1/2 to 12 inches in length and 3/4 to 2 inches in width. The flesh, ivory-white to yellow or salmon-yellow, may be firm, astringent, even gummy with latex when unripe, turning tender and slippery, or soft and mellow or rather dry and mealy or starchy when ripe. The flavor may be mild and sweet or subacid with a distinct apple tone. The common cultivated types are generally seedless with just vestiges of ovules visible as brown specks. Occasionally, cross-pollination with wild types will result in a number of seeds in a normally seedless variety.

CULTURE

Location: Bananas require as much warmth as can be given them. Additional warmth can be given by planting next to a building. Planting next to cement or asphalt walks or driveways also helps. Wind protection is advisable, not for leaf protection as much as for protection of the plant after the banana stalk has appeared. During these last few months propping should be done to keep the plant from tipping or being blown over.

Soil: Bananas will grow in most soils, but to thrive, they should be planted in a rich, well-drained soil. The best possible location would be above an abandoned compost heap. They prefer an acid soil with a pH between 5.5 and 6.5. The banana is not tolerant of salty soils.

Irrigation: The large leaves of bananas use a great deal of water. Regular deep watering is an absolute necessity during warm weather. Do not let plants dry out, but do not overwater. Standing water, especially in cool weather, will cause root rot. Plants grown in dry summer areas such as Southern California need periodic deep waterings to help leach the soil of salts. Spread a thick layer of mulch on the soil to help conserve moisture and protect the shallow roots. Container grown plants should be closely watched to see that they do not dry out. An occasional deep watering to leach the soil is also helpful.

Fertilization: Their rapid growth rate make bananas heavy feeders. During warm weather, apply a balanced fertilizer once a month--a 8:10:8 NPK fertilizer appears to be adequate. A mature plant may require as much as 1-1/2 to 2 pounds of the above fertilizer each month. Young plants need a quarter to a third as much. Spread the fertilizer evenly around the plant in a circle extending 4 - 8 feet from the trunk. Do not allow the fertilizer to come in contact with the trunk. Feed container plants on the same monthly schedule using about half the rate for outside plants.

Frost Protection: Bananas flourish best under uniformly warm conditions but can survive 28° F for short periods. If the temperature does not fall below 22° F and the cold period is short, the underground rhizome will usually survive. To keep the plants that are above ground producing, protection against low temperatures is very important. Wrap trunk or cover with blanket if the plants are small and low temperatures are predicted.

Pruning Only one primary stem of each rhizome should be allowed to fruit. All excess shoots should be removed as soon as they are noticed. This helps channel all of the plant's energy into fruit production. Once the main stalk is 6 - 8 months old, permit one sucker to develop as a replacement stalk for the following season. When the fruit is harvested, cut the fruiting stalk back to 30 inches above the ground. Remove the stub several weeks later. The stalk can be cut into small pieces and used as mulch.

Propagation: Propagation of bananas is done with rhizomes called suckers or pups. Very small pups are called buttons. Large suckers are the preferred planting material. These are removed from vigorous clumps with a spade when at least three feet tall, during warm months. Pups should not be taken until a clump has at least three to four large plants to anchor it. When the pup is taken the cut must be into the mother plant enough to obtain some roots. Plant close to the surface. Large leaves are cut off of the pup leaving only the youngest leaves or no leaves at all. Some nurseries supply banana plants as container grown suckers.

Pests and Diseases: Bananas have few troublesome pests or diseases outside the tropics. Root rot from cold wet soil is by far the biggest killer of banana plants in our latitudes. California is extremely fortunate in not having nematodes that are injurious to the banana. Gophers topple them, and snails and earwigs will crawl up to where they can get continuous water, but these pests do not bother the plant.

Fruit Harvest: Stalks of bananas are usually formed in the late summer and then winter over. In March they begin "plumping up" and may ripen in April. Occasionally, a stalk will form in early summer and ripen before cold weather appears. The fruit can be harvested by cutting the stalk when the bananas are plump but green. For tree-ripened fruit, cut one hand at a time as it ripens. If latter is done, check stalk daily as rodents can eat the insides of every banana, from above, and the stalk will

look untouched. Once harvested the stalk should be hung in a cool, shady place. Since ethylene helps initiate and stimulate ripening, and mature fruit gives off this gas in small amounts, ripening can be hastened by covering the bunch with a plastic bag. Plantains are starchy types that are cooked before eating.

CULTIVARS

The antiquity of the banana and its tendency to produce mutations or sports have resulted in an extensive number of cultivars. Only the common ones growing in California are listed.

Apple, Silk, or Manzana

Dessert type, pleasant sub-acid apple flavor when fully ripe. Fruit: 4 to 6 inches. Grows to 10 to 12 feet. The fruit is not ripe until some brownish specs appear on the skin. From planting until harvest is approximately 15 months.

Cavendish

Resistant to Panama Wilt disease. Clones of this variety are distinguished by the size of the pseudostem. The largest is Lacatan (12 to 18 feet) followed by Robusta and Giant Cavendish (10 to 16 feet). The smallest is the Dwarf Cavendish (4 to 7 feet).

Cuban Red

Very tall (up to 25 feet), very tropical. Skin dark red, with generally reddish pseudostem. Fruit is especially aromatic with cream-orange pulp. 20 months from planting until harvest.

Gros Michel

Commercially, the most important and considered by many to be the most flavorful. Because of its susceptibility to Panama Wilt disease it is being replaced with resistant varieties. Although there is no Panama Wilt in California, it does poorly here as the plant seems to need more heat and it tends to grow more slowly than other varieties

Ice Cream or Blue Java

Medium-tall (15 to 20 feet), bluish cast to the unripe fruit. Fruit: 7 to 9 inches, quite aromatic and is said to melt in the mouth like ice cream. Bunches are small with seven to nine hands. 18 to 24 months from planting until harvest.

Lady Finger

Tall (20 to 25 feet), excellent-quality fruit, tolerant of cool conditions. 15 to 18 months from planting to harvest.

Orinoco

Commonly grown in California for years as a landscape plant. Grows to 16 feet, more cold hardy than any other. 15 to 18 months from planting to harvest. Flavor is good, texture is less than perfect, but when properly grown and cultivated it can produce enormous stalks of fruit. Excellent in banana bread. Sometimes called horse, hog or burro banana, it can be purchased at most nurseries.

Populu

A Hawaiian variety with short, salmon-pink flesh, plump fruit that may be cooked or eaten fresh. A slender plant preferring a protected area with high humidity and filtered light. Grows to about 14 feet tall.

Valery

A Cavendish clone resembling the Robusta. Some believe them to be the same. The Dwarf Cavendish is the most widely planted as it is better adapted to a cool climate and is less likely to be blown over.

Williams

The same as Giant Cavendish. Originated from a mutation of Dwarf Cavendish found in Queensland, Australia. A commercial banana grown in many countries that does well in California. 10 to 16 feet in height and has a distinctive long, very large bud. The Del Monte is a Williams.

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