PLANTAIN PRODUCTION

PLANTAIN

PLANTAIN

Introduction

In Guyana, there are several varieties of plantains grown but farmers as well as consumers show a definite preference for the 'Creole plantain'. It is a well adapted sturdy plant grown on the Coastal Plains and on the levees of the lower reaches of the rivers. It is used basically as foods in a variety of preparations. The mature but green fruit is boiled for immediate consumption or ground into small balls (foo foo) for use in soups. It is also boiled in coconut milk as a component in 'metagee' or it can be thinly sliced and fried into 'plantain chips'. When ripe, the fruit is either boiled or sliced and fried. The mature green fruit can be dried and processed into 'plantain flour' or used in other snack food preparation.

Plantains originated from South- East Asia where it remains fairly important. It has become an important staple in many African countries. In Central and South America, it is produced both for consumption and export. Plantains are a major sub group of the cultivated banana (*Musa* spp). It is a cross between *Musa acuminate* and *Musa balbisiana*. This cross produced three different types:-
Type A: Contains a low starch and high sugar content when ripe. This is known as banana.
Type B: Is the true plantain which is starchy even when ripe and is only eaten when cooked. It differs in shape from banana in that it carries a pointed tip where as that of banana is blunt.
Type C: Is a starchy banana used for cooking. It is known as cooking bananas.

Varieties of Plantain

In Guyana the main varieties of plantains cultivated are: 'Horse', 'Creole' and 'horn'. The following are descriptive features of the various types:

Medium French a/k 'Creole' Plantain – This variety achieves a height of about 2.5 m (8 ft) and a circumference of 60 cm (2ft). It produces between 30 – 38 leaves before fruiting and takes 12 months to produce a mature bunch (Figure 1). The bunch carries as many as 5-8 hands and weigh between 11-12 kg (25 – 50 lbs). It produces many shoots.

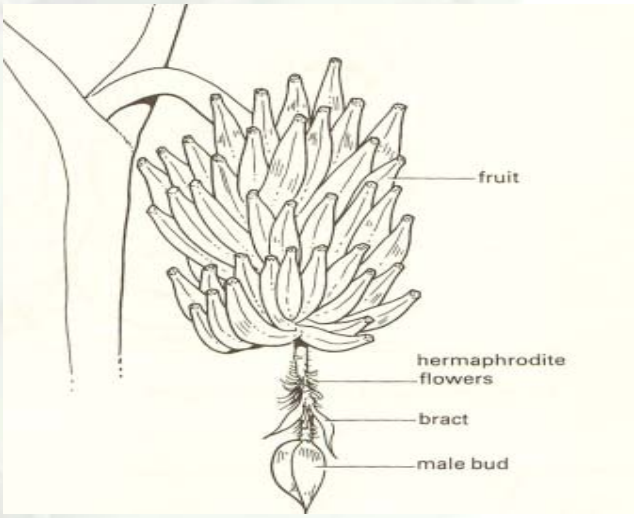

Fig 1. Medium French Plantain

False Horn a/k 'Horse' Plantain – This variety is distinguished by the small number of hands, usually with few fingers on a bunch that weighs about 10 kg (20 lbs) (Figure 2). It is similar to the Medium French Plantain and produces many suckers.

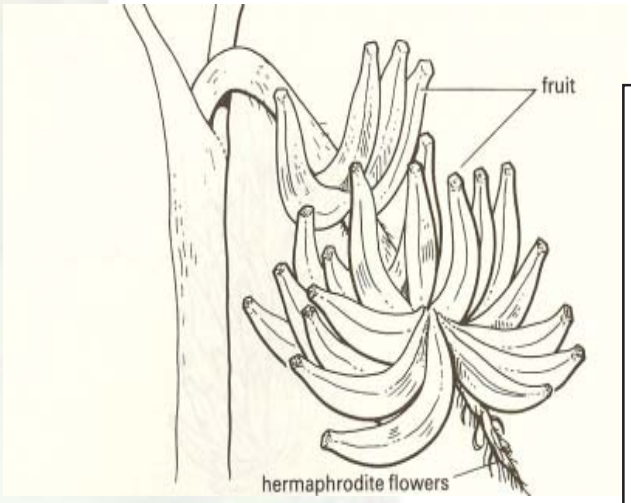

Fig 2. False Horn Plantain

True Horn a/k 'Horse' Plantain – This variety usually has between one and three hands (Figure 3). The fingers are few in numbers, seldom as much as ten. These are longer and stouter than those of the False Horn. It is less important to the farmers because it is not prolific as the other varieties.

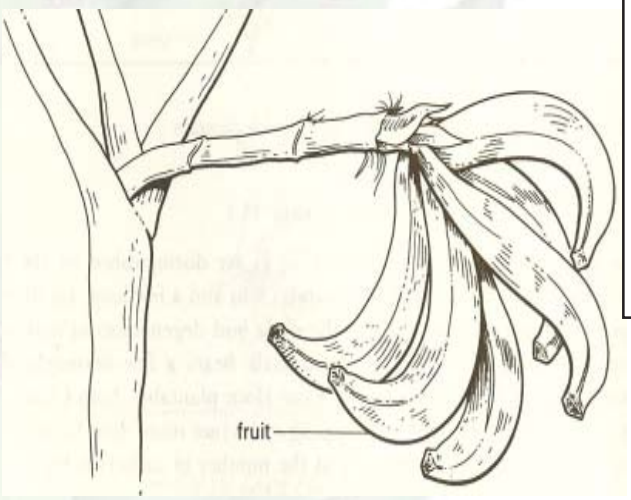

Fig 3. True Horn Plantain

Giant French a/k 'Giant' Plantain – The variety, as the name implies, is robust and tall. It has a girth of around 70 – 75 cm (2- 2.5 ft) and an average height of about 5 m (15 ft). The bunch is very large weighing as much as 90 kg (200 lbs) with many hands ad short fingers (Figure 4). This variety produces more than forty leaves prior to flowering and takes as much as fifteen to eighteen months to produce a mature bunch. It does not produce many suckers from its base but there is often a fine successor.

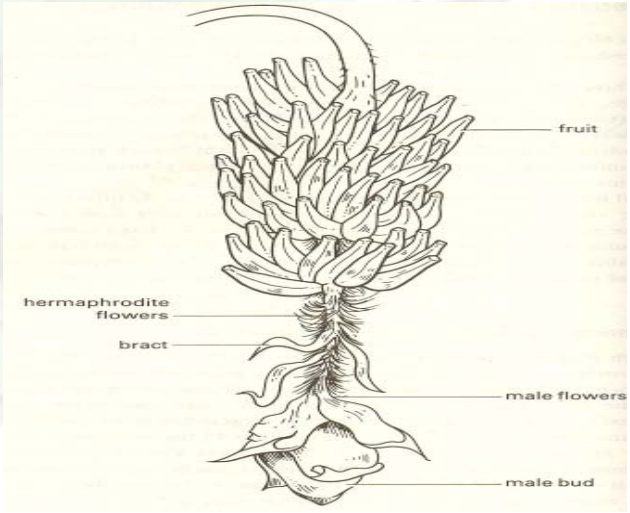

Fig 4. Giant French Plantain

PLANTAIN

PLANTAIN CULTIVATION

General Botany

Plantains are large, perennial, herbaceous plants consisting of underground stems known as corms or bulbs. The corm is the basal part and has a central bud from which leaves and flowers initiate.

A large number of roots form from the corm and often remain grouped together in the upper 30 cm layer of the soil. The corm also has lateral buds of which 3-4 become suckers. The leaves of the plantain consist of three parts: the sheath, the petiole, and the midrib which bears the leaf blades. The sheaths extend from the base of the plant forming the 'trunk' or pseudo stem which, as it grows thinner, forms the petiole and then the midrib. When plantain has formed a number of leaves the terminal bud of the corm develops, rises in the pseudo stem and produces an inflorescence, which emerges from the center of the leaf cluster and turns downwards forming the bunch.

Environmental Requirement

Environmental factors that affect the growth of plantains include:-

- Rainfall and temperature – Plantain requires an evenly distributed rainfall ranging between 120 and 160 mm per month. Regions where the dry season lasts longer than three to four months, should be avoided unless supplementary irrigation can be provided. Temperatures (28 -32^{0}C) are also ideal for the growth of the crop. Temperatures below 18^0 C and above 36^0 C will adversely affect growth.
- Wind – Plantain plants have weak rooting systems relative to the size of their aerial parts and therefore stormy winds can cause considerable damage. Areas sheltered from winds are preferred, or the provision of wind breaks or even the propping of plants will be required.
- Light – Sunny conditions are favourable for plantains, since a high degree of sunlight is beneficial to growth and curtails the development of fungal diseases.
- Soils – Plantains require light, deep soils that will enhance root development and penetration. Heavy soils with poor drainage or those which compact easily should be avoided. Sandy loam and silty clay loam soils rich in organic matter are ideal for good growth and development.

Land Preparation

Lands under forest should be cut and wind rowed. Burning should be done only on the wind rows. This operation leaves the organic matter intact in the top soil and helps to maintain good soil structure. Lands which were previously cleared and used in the recent past should be ploughed with light machinery to a depth of 10 -20 cm (6"-8"). Deeper ploughing should be avoided as much as possible. Adequate drainage must always be provided. Planting Holes – Holes for planting should be prepared at least four weeks prior to planting. Dig holes 60 x 60 x 60 cm (2'x2'x 2'). The size is important, for even if the planting material is small, it allows the roots to spread out easily in the area provided. A poorly developed root system retards growth which results in small and poor quality bunches being produced. The holes should be spaced 3.6 m (12') apart if inter planted with other crops and 2.4 m (8ft) if planted in pure stands. In preparing the planting holes, separate the top soil from the sub soil. The top soil is then placed at the bottom of the hole and the sub soil above to form a mound. After planting, the holes are filled with the remaining soil (Figure 5).

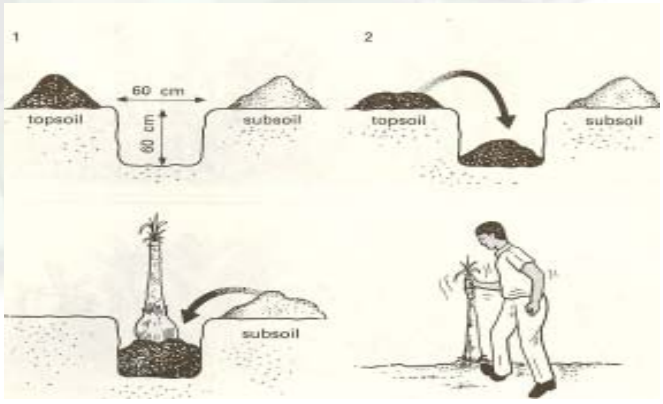

Fig 5. Preparation of planting holes and planting

SELECTION OF PLANTING MATERIAL

There are three types of planting materials: the Sword Sucker, the Maiden Sucker, and the Bull Head (Figure 6).

The **Sword Sucker** is the choice above all the other planting materials - the longer it is with a full corm at the base, the better it will grow under favourable conditions. It has the advantage of having an adequate supply of food in the corm to enhance rapid growth and with less chance of being affected by pests than other types of planting materials.

The **Maiden Sucker** is a young plant that has not yet borne fruit.

The **Bull Head or Corm** is the round under ground basal section of the plant from which the roots and leaves emerge.

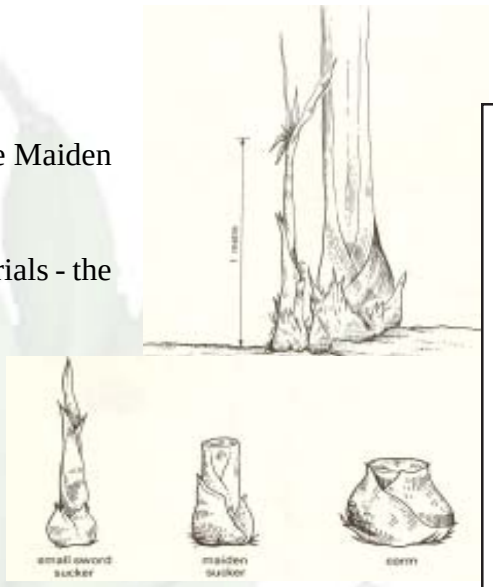

Fig 6. Types of planting materials

PLANTING

The neck of the sucker, where the stem meets the corm, is placed slightly below soil level in the previously prepared planting hole. The hole is then filled with the remaining soil and lightly earthed – up around the sucker.

Maintenance of Cultivation

General Maintenance

Weed control is most importan during the first four – five months after planting. There after, as the plants develop, the soil is covered and weeding will no longer be necessary. Removal of old, dried out, handing leaves should be done frequently.

After flowering, staking with bamboo or propping with forked poles is advisable to support the plants and prevent them from falling during strong winds. Two or three suckers of different sizes should be allowed to grow on each matt in order to stagger production. Other suckers are to be carefully pruned, uprooted and used for further planting.

Fertilizer Application

As a general rule, before applying fertilizers, the soil should be analyzed to determine the types and amounts to be used. If a soil analysis (soil test) was not done, the following are the recommended rates can be applies to each plant:

Urea – 450 gm (1 lb)
Triple Super Phosphate (TSP) – 225 gm (1/2 lb)
Muriate of Potash (MoP) – 225 gm (1/2 lb)

With a spacing of 2.4 m x 2.4 m (8’ x 8’) one hectare will accommodate 1,700 plants/ ha (approximately 680 plants/ ac). Hence for one hectare the following amount of fertilizers will be required:

Urea – 300 kg (680 lb)
TSP – 150 kg (340 lb)
Muriate of Potash – 150 kg (340 lb)

All the TSP and one half of the Urea and Muriate of Potash should be applied in the hole at planting. At flowering, apply the remainder of the Urea and Muriate of Potash.

NUTRIENTAL DISORDERS

Nitrogen

This is the most important element for plantains. The symptoms of nitrogen deficiency are generalised chlorosis of the plant, with accentuation of the rose tints on the petiole wings (Figure 7).
There is stunting of the growth of the plantain, the rate of leaf emission decreases, the internodes are short, the plant tends to become engorged and the bunches are small.
In all cases, split dressings are preferred (4-6 applications/year), in order to minimise the leaching caused by heavy rains. Application of nitrogen should be avoided in the dry season and at the height of the rainy season. The nitrogen is applied in a ring around the plantain plant, approximately 0-5 cm from the corm

Fig 7. Symptoms of Nitrogen deficiency

Potassium

Potassium deficiency is characterised by very rapid yellowing (orange/yellow) of leaves numbered 5 or 6 (the leaf numbered I is the last completely unfurled leaf emitted). The rib of these leaves is very often broken two-thirds of the way along its length (Figure 8).
Symptoms of potassium deficiency may appear where the soil is sufficiently rich in potassium. In such a case, it is possible that the element is being poorly absorbed owing to a root system which is inadequate or in poor condition.

Fig 8. Symptoms of Potassium deficiency

Symptoms of potassium deficiency often appear at the time of flowering. It is at this stage of its development that the plantain plant has the highest demand for potassium. Potassium must therefore be applied two to three months prior to the estimated date of flowering. Potassium plays a very important part in the growth and development of the fruit.

Magnesium

The first symptoms of magnesium deficiency is marginal chlorosis of the older leaves, extending increasingly towards the midrib. Part of the lamina always remains green on either side of the rib. As the leaf gets older, it becomes almost entirely golden-yellow, with numerous necrotic patches. As they die, the petioles and leaves rot, giving off a smell of decay. (Figure 9.)
Blue disease (‘1e bleu’) is often associated with magnesian chlorosis; it is due to an imbalance of potassium and magnesium. The main symptom of the disease is purple-blue and brown marbling, which is visible on the underside of the petioles and main veins.

Fig 9. Symptoms Magnesium deficiency

Calcium

The symptoms of calcium deficiency are a reduction in the length of the leaves and a slowing down of the rate of emission. Later, a thickening of the secondary ribs will be noted on the younger leaves, giving them a crinkled aspect (Figure 10).
Finally, there is dentate interveinal chlorosis directed towards the midrib. The chlorosis develops into necrosis which may occur in the middle of the blade and form 'button holes'.

Fig 10. Symptoms Calcium deficiency

Phosphorus

Phosphorus deficiency is characterized by blue green coloration of the leaves. On the lowest four or five leaves there is marginal necrosis, developing in an angular manner towards the midrib.

INSECT PEST MANAGEMENT STRATEGIES

Plantain/Banana is grown on a wide range of soil types throughout Guyana, and is affected by insect pests, diseases and weeds which adversely affect yields. The most devastating pest is the **MOKO DISEASE**, to which all the commercially grown varieties are susceptible.

Insects (particularly the Plantain/Banana **ROOT WEEVIL**) are also responsible for substantial yield losses.

WEEDS, contribute to yield losses through competition for water and nutrients, and by serving as alternate hosts for insects and diseases.

It is essential that the establishment of cultivations be done with clean and healthy planting materials. Proper field sanitation ensures a clean environment for crop growth. The utilization of adequate agronomic practices such as fertilizer application and weed management contribute to plant vigor

Plantains and Bananas are affected by three major insect pests:

a. **PLANTAIN/BANANA ROOT WEEVIL** – *Cosmopolites sordidus* (Coleoptera; Curculionidae)

b. **PSEUDOSTEM BORER** - *Lapaeumides licus* (Lepidoptera; Castinidae)

c. **FRUIT SCARRING BEETLE** – *Colapsis hypochlora* (Coleoptera; Chrysomelidae)

a. Plantain/Banana Weevil

This pest is widely distributed throughout the country but is more problematic in areas where the crop is cultivated on a large scale.

Detection of Infestation

i) Existence of tunnels in the corm with all stages of the weevil.

ii) Presence of red marks about 1.3cm (1/2in) to several centimeters long on the pseudostem surface near the corm.

iii) Placing traps around cultivated area. Traps are made by cutting pseudostem about 45cm long (18ins) and placing the cut surface facing the ground. An average of three adults per trap would indicate that infestation needs control.

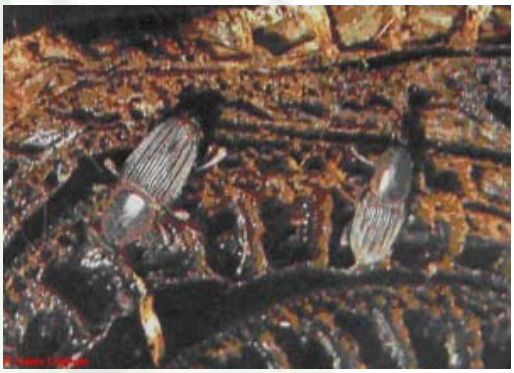

Fig 11. Plantain weevil

Larva

The larva causes damage through feeding and tunneling in the corm. Continuous feeding and tunneling causes the corm to become a blackened mass of decaying tissue. Above ground symptoms are the yellowing of leaves, withering and eventual death of the plants. Infected plants are easily blown over by winds since the roots are weakened. The mature larva, or grub, is about 1- 1.5cm long, creamy-white in colour, fleshy, and are legless, with the body distinctly curved and swollen in the middle (Figure 11).

Adult Weevil

The adult weevil lives under or in newly cut or decaying pseudostems. They are about 1 – 1.5cm long and have a pronounced snout. They are hard shelled, and newly emerged adults are reddish-brown, but soon become uniformly black in colour in its moist habitat of the plantain/banana corm.

Adult Weevil

The adult weevil lives under or in newly cut or decaying pseudostems. They are about 1 – 1.5cm long and have a pronounced snout. They are hard shelled, and newly emerged adults are reddish-brown, but soon become uniformly black in colour in its moist habitat of the plantain/banana corm (Figure 12).

Fig 12. Adult weevil

Control

1. **Sanitation:** - Use clean planting material. Ensure that suckers to be used for planting new fields are free from pests. Remove all trash from suckers and pare the corm to remove all roots and discoloured portions. Pared suckers are further dipped in a 4% Triazophos, Basudin or Vydate L solution.
   Allow suckers to dry for at least twenty-four hours before planting. Suckers so treated will be protected against weevil attack for 3-5 months.

2. **Cultural Control:** - Weeding and fertilizing contribute to the plant vigor which enables the plant to better withstand weevil attack.
   De-sucker and clean matts regularly and remove all dead and decaying matter.
   Remove all plant residues from the previous crop.

1. **Field Treatment of Infested Plant :-** Plants that are infected in the field can be given an insecticidal treatment. The insecticides Triazophos, Basudin or Vydate L are recommended at the rate of 15mls to 4500mls (½ fl.oz. to1gal) water and applied thoroughly to the plant stand.
   The insecticide solution should be sprayed on to the pseudostem immediately above the corm, and the soil immediately around the base of the plant. This treatment should give control for approximately 3-5 months.

2. **Trapping:** - The adult weevil is attracted to cut or damaged pseudostem. During harvesting, the pseudostem from these plants which would have already borne fruit can be split longitudinally and cut into 45cm (18ins) long pieces. The cut surface of each piece can be treated with 0.05% concentration of Triazophos or Basudin solution.. Each cut piece should then be placed with its cut surface downwards on the soil surface between the standing crop. Traps will attract and kill adult weevils during a 7-10 day period.
   Untreated traps can be placed in the field as described above, however, these must be serviced and replaced every 48hours. This system will also rigorously reduce the pest population in the field.

b. <u>Pseudostem Borer</u>

The larva (3.75cm long) bores into the pseudostem at any point up to one metre from ground level. At the point of boring, and evidence of infestation, a slimy, colourless material continuously exudes.

The larvae bore mostly the periphery of the stem, but sometimes attack the core and reach the growing point, thus killing the plant. Once plants are checked regularly, slimy secretions will indicate the location of the larva.

<u>Control</u>

- Practice good field sanitation.
- **Injection Method:** - Make 2 – 3 holes 9cm (3ins) about 60cm (2ft) from the ground. These holes should go down at on 45degree angle and sideways into the trunk. With the use of a dispensing bottle, pour Triazophos 40% E.C. into the holes.
- DO NOT APPLY THIS TREATMENT TO PLANTS WHICH HAVE IMMATURE OR MATURE FRUITS.

c. <u>Fruit Scarring Beetle</u>

The adult beetles feed on almost all stages of the fruit, thus, causing wounds on fruit surfaces. These wounds exude a clear fluid which eventually turns black. These wounds are only superficial and do not extend to the edible portion of the fruit, but renders it unmarketable. Conditions suitable for development of this pest are:-

- poor field sanitation;
- water logged conditions; and/or
- and heavy shade.

Control

i) Good field sanitation;
ii) Good drainage and irrigation;
iii) Sunlight must be able to penetrate the crop canopy;
iv) Good cultural practices; and/or
v) Plantain/Banana bunches can be sprayed with a 0.1% concentration of Sevin 85% W.P.(Carbaryl) solution or 0.05% concentration of Malathion solution or any contact insecticide with limited residual power.

NEMATODE: - *Radopholus similes*
(Tylenchida; Pratylenchidae)

On Plantain/Banana this nematode invades and feeds on the cortex of the roots causing lesions and cavities. The nematode seldom feeds on vascular tissues. Nematode damage to roots results in reddish, elongated flex, parallel to the root axis. The discoloured areas enlarge as the nematode and progeny feed. The older parts of the lesions turn black and shrink while the advancing margins remain red. The root systems are reduced; severely damaged and unable to uptake water and nutrients thus, the plants lack vigor; are stunted, and because of poor anchorage, are prone to topping under bunch weight or to being blown over even by not so strong wind.
Nematode infested plantain/banana does not respond well to fertilizer application, irrigation or other cultural practices. Where there is severe nematode infestation, ratoon crops are hardly produced as there is continued plant loss and significant reduction of suckering

Management

1. Cultural Control:-

a) Nematode free plantain/banana crops can be produced by using clean (uninfected) planting materials (properly pared corms or micro- propagated plantlets). These are planted in new areas or in fields which are free of plant nematodes.
b) Proper field sanitation: - Fields should be kept free of weeds that could harbour the nematode.
c) Good drainage / Irrigation

2. Chemical Control:-

Presently, the standard recommendation for nematode control in plantain/banana crops is the use of clean planting materials (thoroughly pared corms or micro-propagated plantlets), treated with a nematicide, with follow ups at regular intervals. However, due to the environmental impact and consumer health considerations, attempts at breeding nematode resistant plantain/banana cultivars are ongoing.

MOKO DISEASE

Moko disease is the major disease of plantain/banana in Guyana. It is widespread throughout the plantain/banana growing areas. This disease is caused by bacteria which attack the plants. These bacteria enter the plants, grow and block the channels that carry water to all parts of the plant, thus, preventing much needed nourishment. Subsequently, the plant dies. The name of the bacteria that causes this disease is *Ralstonia salanacearun* (Race 2). Rigid sanitary methods are the best means of control as no chemical treatment is available to prevent or control infection.

Symptoms of Moko Disease

The signs indicating the presence of the disease are as follows:-

- Yellowing and drooping of young leaves with brown patches resulting in the death of the plant.
- Premature and uneven yellowing of fruits which, when cut, display black spots or blackening of the pulp.
- Presence of a dark brown to bluish – black ring in the cross-section of the pseudostem (trunk) of the plant.
- Naval, i.e. male flowers ends, wither and become black.
- Breaking of the leaf petioles, wilting, drying and eventual death of plant.

Disease Dispersal

- use of planting materials taken from diseased stands,
- from mother corm into the suckers and followers,
- by insects, e.g. bees, wasps,
- from one country to another by people and goods; by air and sea,
- and the use of un-sterilised farm tools.

Management of Moko Disease

a) use of planting materials from disease free fields,
b) removal and destroy by burning all plants which show any signs of disease,
c) proper field sanitation – plots should be weed free, since “moca-moca” bush and other weed species may keep Moko bacteria alive,
d) disinfection in the fields can be achieved by flaming tools (heat exposure) or sterilised in a solution of 70% ethanol (alcohol), formaldehyde (formalin) 10% or chlorine solution 10% (marvex /bleach), for at least 10 minutes,
e) provision of adequate drainage to avoid run-off water from contaminated fields so that the disease cannot be transmitted from field to field,
f) if fields are already infested, then all plants should be removed and destroyed by burning. The fields must then be fallowed for at least 12 months,
g) crop rotation – crops, such as yams, sweet potato and eddoes may be used,
h) and before leaving the diseased site, soak hands, tools, boots etc. in alcohol, bleach or formalin solution.

Weed Control

Weed control is the most important operation from planting time onwards. Weeds become a major problem soon after establishing a new plantation. Regular light hoeing is preferable while plants are small, and weeds must be destroyed before seeding. Eventually, the weed problem should diminish as the increasing shade from the growing sucker leaves increases, thus, suppressing weed growth.

When plants are 1 – 1.5m tall, selected herbicides can be introduced to control weeds.
Herbicides selected for use on plantains and bananas are Ametryne, Simazine, Glyphosate, Diuron and Paraquat.

Ametryne, as a pre emergence herbicide can suppress general weed growth for 3 – 4 months. When the crop is about 6 months old, a contact herbicide can be used, such as Paraquat. This herbicide is effective on broad leaved and other annual and perennial weeds.

In established plantations, perennial grass species can build up, and become very competitive with the crop. At this point a systemic herbicide should be used e.g. Glyphosate and or Totacal.

PRE POST HARVEST MANAGEMENT

BUNCH COVERING

Bunch covering is the use of polyethylene to provide protection to the fruit surface against wind damage, leaf and petiole scarring, dust, light hail, sunburn, bird feeding, and handling damage during harvest and transport. A significant reduction in peel surface damage from insect pests may be obtained by covering the plantain or banana bunch shortly after pollination. In addition, the incidence of postharvest anthracnose disease has been shown to be significantly less on fruit from sleeved bunches. The net effect of bunch cover use is better fruit quality and increased marketable yield.

The use of polyethylene bunch covers is widespread throughout the commercial banana growing regions of the world. They are also commonly used to protect export market intended plantain fruit during development. The practice is regarded as essential to improve the market quality and yield of the fruit.
Bunch covers are typically made of thin plastic (low density polyethylene; 5 to 40 microns) and are 81.3 to 91.4 cm (32 to 36 inches) wide and range in length from 1 to 1.5 meters (3.3 to 5 feet). The thin bunch covers are designed to be used only once. The thicker ones can be re-used, but the removal process is time consuming and it is difficult to avoid damaging the plastic. Commercially available bunch covers generally are colored white or translucent blue. The plastic may also be colored silver to reflect heat.
The recommended type of bunch cover varies according to environmental conditions.
Thicker non-perforated types are best suited for cooler sub-tropical growing areas (i.e. Australia) where heat build-up inside the cover is desired (Figure 3). In tropical growing environments like Guyana, the thicker non-perforated bunch covers usually result in excessive heat and humidity build-up inside the cover. Thin perforated bunch covers which allow for aeration inside the cover are the preferred type for tropical growing areas. The optimum type of perforation design may vary according to growing location. The two most widely used perforated bunch covers for tropical areas are the pinhole type which has 0.47 cm diameter holes, and the 1.27 cm (1/2 inch) hole type.

The distance between perforations (vertically and horizontally) is 2.5 X 3.0 cm (1 to 1.2 inches) in the pinhole style and 7.6 X 7.6 cm (3 x 3 inches) in the half-inch style of bunch cover. Perforated bunch covers may also be impregnated with a slow-release volatile insecticide to protect the fruit against insect pests during growth and development. The most commonly used insecticide impregnated in the plastic is chlorpyrifos, an organophosphate insecticide sold under the trade names of Lorsban or Dursban. Several other insecticides, dichlorvos and diazinon, are also effective in warding off bunch pests. They are typically impregnated into plastic strips which are placed inside the bunch cover. The preferred type of bunch cover depends on the amount of insect pressure, environmental conditions, and market requirements.

Source and Cost

Bunch covers are highly specialized items available from only a few plastic companies in the areas of commercial banana production. There is no company in the U.S that makes bunch covers. Therefore, a more extensive worldwide search was made and several sources of bunch covers were found. Several companies in Costa Rica, Guatemala, Mexico, and Ecuador fabricate a wide diversity of bunch cover types for the Latin American banana export industry. Commercial growers throughout the region, and as far away as Hawaii, use these companies as their source of bunch covers. The specific company which supplied the bunch covers for the introductory trials in Guyana was Empaques Universal, S.A., located in Costa Rica (phone: 506-438-0525; fax: 506-438- 0557). The other source of bunch covers was a company in Queensland, Australia, called Green Harvest, which sells a non-perforated bunch cover for the sub-tropical banana industry in the Queensland area (phone: 617-5494-4676; fax: 617-5494-4674).

Bunch covers can be purchased in rolls, which range in length from 60 to 100 meters, or as pre-cut bags. The rolls and pre-cut bags come in different widths and thickness of plastic. In addition, the bunch covers come in different styles, including non-perforated, perforated (pinholes and 1.3 cm [0.5 inch] holes), and perforated with chlorpyrifos impregnated insecticide. A typical bunch cover length is 1.2 meters (4 feet), therefore, a total of 83 bunch covers can be obtained from one 100 meter roll. The cost per roll and per bunch cover varies slightly depending on the style and length of bunch cover and the number of rolls purchased. The cost per 100 meter roll (from Empaques Universal) is approximately $3.60, or slightly less than $0.05 per bag. Another company in Costa Rica (Yanber S.A., phone: 506-763-3245; fax: 506-222-6244) sells pre-cut chlorpyrifos bunch covers in 500 unit amounts for $34. This is equivalent to about $0.07 per bunch cover.

However, these prices do not include the freight cost from Costa Rica to Guyana. Nevertheless, the price is very reasonable in relation to the positive benefits obtained from use of the bunch covers. It may also be possible to source the bunch covers at competitive prices from other Caribbean banana-growing countries (i.e. Jamaica, St. Lucia, Guadeloupe), Surinam, Colombia or Venezuela).
The cost of the non-perforated bunch cover from Australia is $1.23 per meter. Thus, a 1.2 meter length bunch cover costs $1.48, plus freight. This is extremely expensive, and in addition, this type of bunch cover is not likely to be adapted to the humid, tropical production areas of Guyana.

Timing of Application

Bunch covers should be applied after the bracts covering the hands have fallen, the fingers are curling upwards, and the floral remnants have hardened. Typically, this occurs about 2 to 3 weeks after flowering. The schedule for bunch covering in a plantation is usually every 1 to 2 weeks. A colored polyethylene strip of a different color is commonly used to attach the bunch cover to the stalk (peduncle). This helps the workers identify the proper bunches to harvest. The time period from bunch covering until harvest will be slightly over 2 months.

Method of Application

Bunch covers are usually fabricated in the form of a continuous tube made to the desired width. The tube should be cut in lengths of 1 to 1.5 meters, depending on the length of the plantain or banana bunch. The hollow plastic tube should be slid up the bunch from the bottom and securely tied or attached to the bunch stalk above the first hand of fruit. The bunch cover should be left open at the bottom and hang at least 150 mm (6 inches) below the last hand of fruit. If bunches are composed of more than 7 hands, removal of the terminal bell (male flower bud), which keeps on growing, will result in somewhat fuller bananas, thus increasing bunch weight. The cut should be made about 10 cm (4 inches) below the last hand so that the rotting tip of the severed stalk will not affect the fruits.

Disadvantages of Bunch Covers

Although the positive benefits of bunch cover application typically far outweigh the undesirable effects, it is important to point out several possible negative consequences. The use of non-perforated bunch covers in hot, humid climates such as Guyana may damage the bunch physiologically due to overheating, rotting, and premature ripening. In addition, insect pests may proliferate inside non-insecticide treated bunch covers. Another negative consequence of ineffective bunch covers is the economic loss due to the extra cost of the material and the labor needed for application.

In tropical countries, the negative consequences are avoided by using perforated bunch covers for aeration and cooling, and insecticide-impregnated covers for pest control. Postharvest shelf life and market quality of plantains and bananas are significantly influenced by pre-harvest production practices. Covering the developing plantain/banana bunch in the field shortly after flowering with a perforated bunch cover is usually very effective in reducing both physical and insect damage to the peel. This practice is widely done throughout the world, especially where plantains and bananas are grown for export. It is likely the positive benefits of this practice will be noticeable for Guyanese producers as well.

Harvesting

Plantains require about 3 months from the beginning of flowering until harvest. Multiple fruits are produced on a large bunch, weighing between 30 to 100 lbs. Within the bunch are clusters of double rows of fruit called 'hands', and individual fruit called 'fmgers'.

Crop Maturity Indices

Maturity standards for plantains are less precise than they are for bananas. Several different external and internal fruit characteristics can be used to determine plantain maturity. These include fruit diameter, age of the bunch, angularity of the fruit, length of the fruit, and peel color. The stage of maturity for harvest depends on the intended market destination. Locally marketed plantains can be harvested at a more advanced maturity stage compared to export market fruit. Export market destined fruit should be harvested the day before or the same day of shipment.

Plantain maturity is related to the diameter of the fingers. This is determined by measuring the diameter of the fruit at its midpoint with a pair of calipers (Figure 13).

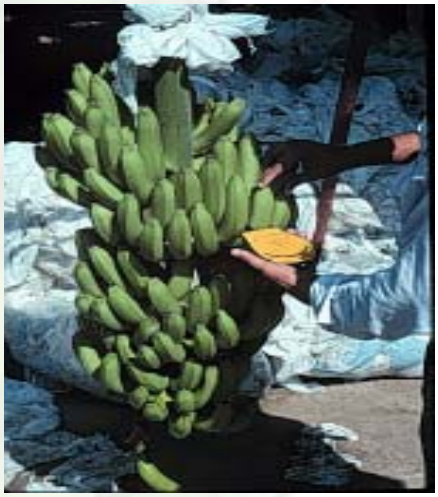

Fig 13. Caliper used to measure plantain fruit maturity.

Another method for estimating plantain maturity is to record the age of the bunch. The time from when the fruit bunch first becomes visible ('shooting') is recorded. Bunches can be tagged with different colored ribbons at the
time of shooting, and subsequently harvested after the appropriate time for
the particular cultivar, based on the season of the year and experience.
The color of the ribbons is changed weekly to coincide with the time of shooting and subsequently the age of the bunch.

A third method used to determine harvest maturity is to observe the shape (fullness) and angularity of the fruit. Immature fruit is angular in cross-sectional shape and has distinct ridges. As the fruit matures, it becomes less angular and more rounded or full. The degree of roundness differs between cultivars and location of the hand on the bunch. Typically, the fullness of the fruit on the middle hand is measured.

The appropriate shape to harvest the fruit depends on the market destination. Fruit intended for the domestic market should be harvested when the fruit shape is nearly round. Export market fruit intended for the Caribbean market should be harvested when the fruit shape is slightly angular, while fruit intended for long distant export markets (i.e. Canada, U.K.) should be harvested when the fruit shape is more noticeably angular.

A fourth way of estimating plantain bunch maturity is to measure the length of the edible pulp portion of the fruit from the fingers in the middle hand. The length should be a minimum of 15 cm for the domestic market and 18 cm for the export market.

Finally peel color is another frequently used method of assessing fruit maturity. The peel remains green throughout growth and development of the fruit until it reaches physiological maturity. It then changes to a yellow color during ripening.

However, plantain fruit should be harvested when the peel is green in color to withstand the rigors of handling and distribution. Internal fruit composition changes dramatically during plantain fruit ripening. At physiological maturity, the fruit is fully developed in size, green in peel color, and at its highest level of starch. The starch will progressively be converted to sugar as ripening progresses.

The stage of harvest maturity of plantains will depend on the target market. Plantains for local markets are harvested at a more advanced stage of maturity than those for exportation. However, if the fruit is too mature at harvest, particularly following irrigation or rainfall, fruit splitting can occur during handling. Also, mature fruit may ripen prematurely during transport or storage (Figure 14).

Fig 14. Splitting of mature fruit (bunch at right) after heavy rainfall.

Harvest Methods

The usual method of harvesting plantains is to partly cut through the pseudostem approximately 2 m from the ground. This allows the plant to bend over under the weight of the bunch. The bunch is then cut off and carried away by hand to a nearby collection site or packing area.

Preparation for Market

Transportation to Collection Area

After harvest, the plantain bunches are taken from the field to a collection area or consolidation site, where they are often piled up on one another (Figure 15). Piling should be avoided, as it results in considerable bruising injury and mechanical damage to the fruit. Rudimentary grading at this point should be done to eliminate diseased, damaged, or over-ripe fruit. The fruit should not be exposed to sun, rain, or wind. Fruit temperature of plantains exposed to the sun may be up to 10°C higher than shaded fruit. Collection points for the harvested fruit should be shaded and easily accessible to vehicles for transportation

Fig 15. Plantain bunches piled together at collection site near Parika.

Transportation to Packing Area

The bunches of plantains from the collection sites are normally loaded in bulk in trucks (Figure 16) or vans for travel to Georgetown or other domestic market destinations. The bunches are piled on top of each other to maximize the load capacity and often over several hundred bunches are stuffed in the truck bed. No specific measures are taken to protect the fruit from physical damage during transport. Considerable peel damage is incurred during loading and unloading and injuries such as bruising from compaction during the journey are common. In addition, many fingers may twist and fall off the bunch. Significant losses occur during transport in fruit intended for the export market, as there is less tolerance for damaged fruit in these markets.

Fig 16. Loading of plantains in bulk for transport to Georgetown.

Suggested changes for reducing mechanical injury and damage to the bunches during transport include:

- use of foam padding along the bottom and side walls of the truck
- placement of foam padding between the bunches
- creating several levels in the truck bed with horizontal boards to stack the bunches
- de-handing the bunches and transport in stackable field containers
- driving the transport vehicle at a low speed

De-handing plantains in the field and packing in stackable plastic field containers is highly recommended for export market fruit. Plastic field containers are easy to clean, widely adapted for use on a number of crops, and very durable (Figure 17). They also impart significantly less damage to the fruit compared to wooden crates or reed baskets.

Figure 17. Stackable plastic field containers for packaging and transportation of plantain hands.

Cleaning

The cleaning step differs depending on whether the fruit is intended for the domestic or export market. If the plantains are to be sold domestically, usually they can be cleaned with cotton gloves or a moist cloth to remove surface dirt once the hands have been cut from the main stalk (peduncle). Export market fruit must be subject to a more rigorous cleaning procedure.

Once the export market fruit arrives at the packing area it must be properly cleaned and sanitized to maximize its potential market life (Figure 18). If the fruit arrives on intact bunches, the hands need to be cut smoothly from the main stalk using a sharp curved knife or blade. A portion of the crown is left attached to the hand. After de-handing, the hand should be moved by grasping the crown area. Moving the entire hand by lifting one or two fingers will cause pedicel bruising and possible severing of the individual fruit from the hand.

When the hands are cut off, sap (latex) oozes from the severed crown. This substance oxidizes and causes a dark stain or blemish on the peel. In order to avoid latex burn, the hands can either be left to drain for 2 minutes on de-Iatexing trays or floated in water tanks to wash the latex off the fruit surface. If de-Iatexing trays are used, absorbent cellulose crown pads impregnated with thiabendazole should be applied to the cut crown area after the latex has stopped exuding. Crown pads are commonly used by small-scale growers.

Figure 18. Cleaning of plantain fruit destined for Barbados.

Large-scale plantain growers float the plantain bunches in a water tank to remove any adhering dirt from the peel surface and to coagulate the exuded latex (Figure 19). The water tank should be filled with clean flowing water sanitized with 150 ppm free chlorine, 1 % aluminum potassium sulphate (alum) to coagulate the latex, and an appropriate fungicide (except for bananas marketed as ‘organic’). The fruit should remain in the water tank at least 15 minutes or until all oozing of latex ceases

Figure 19. Cleaning and de-latexing of plantain fmit in water tank.

In some packinghouses, separate washing and de-Iatexing tanks are used. The fruit is first washed for about 5 minutes, followed by de-Iatexing for about 10 minutes. The fungicide can be included in the de-Iatexing tank, or sprayed onto the crowns with a hand sprayer while on the drying tray. Alum may also be applied at the same time and serves as an anti-oxidant to prevent subsequent latex exudations from staining the peel.

The recommended fungicides for postharvest disease control in plantains are thiabendazole (500 ppm) and/or imazalil (1000 ppm). It is very important to keep the fungicides agitated to prevent the active ingredient from settling out. Relatively large amounts of the fungicide are usually required because the wash water becomes dirty and must be changed from time to time.

The water flow transports the hands from the de-handing side of the tank to the opposite side where the hands are separated into clusters of 4 to 8 joined fingers, and small or defective fingers are removed. Some markets require each finger to be separated from the bunch. The Clusters are removed from the tank, placed on trays, dried, and graded (Figure 20).

Figure 20. Plantain fruit in drying trays after de-handing and washing.

The packing area should be located in an easily accessible area that is shaded, covered, and has good air flow.

Grading

Quality standards vary for different markets. They are the most stringent for the North American and European export market and the least stringent for the domestic Guyanese market. However, the following grade standards apply to green plantain fruit on the bunch for both domestic and export markets:

- fruit must be clean and free of adhering dirt on the peel
- fruit must be well developed, without pronounced ribs or marked angles
- fruit must be similar in shape, color (pale green), and skin typical of the variety
- fruit must be free from visible decay
- bunches must be well trimmed
- the neck, which hold the stems of the fingers together, must be between 1 to 2.5 cm from the pulp
- fruit must be free of damage, or defects caused by malformation, which detract from appearance or edibility

In addition to meeting the above requirements, the Guyana National Bureau of Standards has three grade classifications for plantains based on size. Size is determined by weight and length of individual fruit.

	Minimum weight (gm)	Minimum length (cm)
Grade I	70-110	18
Grade II	250	15
Grade III	140	10

The U.K. market requires a minimum finger length of 22 cm (9 in) and the fruit must arrive with a green peel color. In addition to minimum finger length, the fruit must be free of objectionable blemishes. A small amount of healed scar tissue or superficial insect damage may be tolerated in certain markets. Mechanical scarring of the peel is the single most important fruit defect and can be caused by poor plantation management and harvesting procedures or during transport to the packing area (Figure 21).

Figure 21. Significant scarring and mechanical damage to the peel occurs during transport and handling

Packing

Plantains sold in the domestic market are usually not packaged. They are transported to market as intact bunches and de-handed at the market site (Figure 22). However, the external fruit appearance would benefit by de-handing the fruit from the bunch and packing the hands with the finger tips pointed down in padded cartons prior to loading in the transport vehicle.

Figure 22. Plantains sold from intact bunches in the Bourda market.

Plantains exported to Barbados or North American market destinations by air should be packed in strong, well-ventilated cartons, typically containing 18 kg (40 Ib) of fruit. The cartons must be strong enough to withstand the forces of palletization and well ventilated to maintain an even fruit temperature during transport. An additional 2 Ibs of fruit should be added to the 40 Ib carton to account for weight loss during storage and transport.

A commonly used package in the international trade of plantains is a full-telescopic two-piece corrugated fiberboard carton with a bursting strength fJf275 Ib/irl (Figure 23). Top and bottom ventilation, in addition to side vents are required, particularly where sea-shipments are used. A double-walled bottom is preferred. Typical carton internal dimensions are 20 cm x 51 cm x 34 cm (7.9 in x 20 in x 13.4 in).

Hands or clusters should be packed in a neat, regular pattern to minimize movement and chaffing of the peel. The cartons may be lined with a thin polyethylene film to prevent scuffing of the fruit against the fiberboard. The hands in the bottom of the carton should be placed in the center and overlapped with the adjacent hands. The crowns should face the base of the carton. A thin divider should be used to separate the two layers of fruit. Fruit should never be forced into the carton. Also, the fruit should never be overpacked so it forces the top of the carton to bulge out. This will result in considerable abrasion and mechanical damage to the plantains. Mechanical damage will result in blackened areas of the peel which will soften and often succumb to fungal infection

Marine container transport is an option if transit time is less than 2 weeks and sufficient cooling capacity is available to maintain storage conditions between 12°C to14°e (54°F-57°P), 90% RH during transit. If this mode of transport is used the fruit should be packed in cartons lined with perforated plastic film or enclosed in semi to permeable sealed plastic bags and the transport temperature should be maintained between 12°C to 14°C. The modified atmosphere of low 02 and high C02 established inside the sealed bags from respiration of the fruit will significantly extend the shelf life of the plantains. The plastic film or bags will reduce moisture loss during transport and provide some protection from chafing damage. The fruit should also be harvested at the proper maturity stage to avoid ripening during transport.

Fig 23. Typical export carton used for plantains.

Temperature Management

The optimal storage and transport temperature for maximizing plantain shelf life is between 12°C to 14°C. This temperature will delay ripening, but avoid low temperature chilling injury. The average shelf life of mature green harvested plantains stored at 12°C is between 4 to 5 weeks. If the fruit is harvested at a more advanced stage of ripening and/or the storage temperature is higher, the shelf life will be less. Green harvested plantains that are stored under ambient temperatures in Guyana will have a shelf life of about 7 to 10 days. At temperatures above 30°C, the pulp will soften but the peel will remain green. However, shelf life of green mature plantains can be extended at ambient temperatures by storing the fruit in polyethylene bags with an ethylene absorbent (potassium permanganate) wrapped in porous paper. In this microenvironment, plantain shelf life can be extended up to 4 weeks at 29.4°e (85°F) and up to 7 weeks at 12.7°e (55°F). To obtain maximum shelflife from plantains, ethylene must be removed from the atmosphere and the fruit must be kept at 12°C.