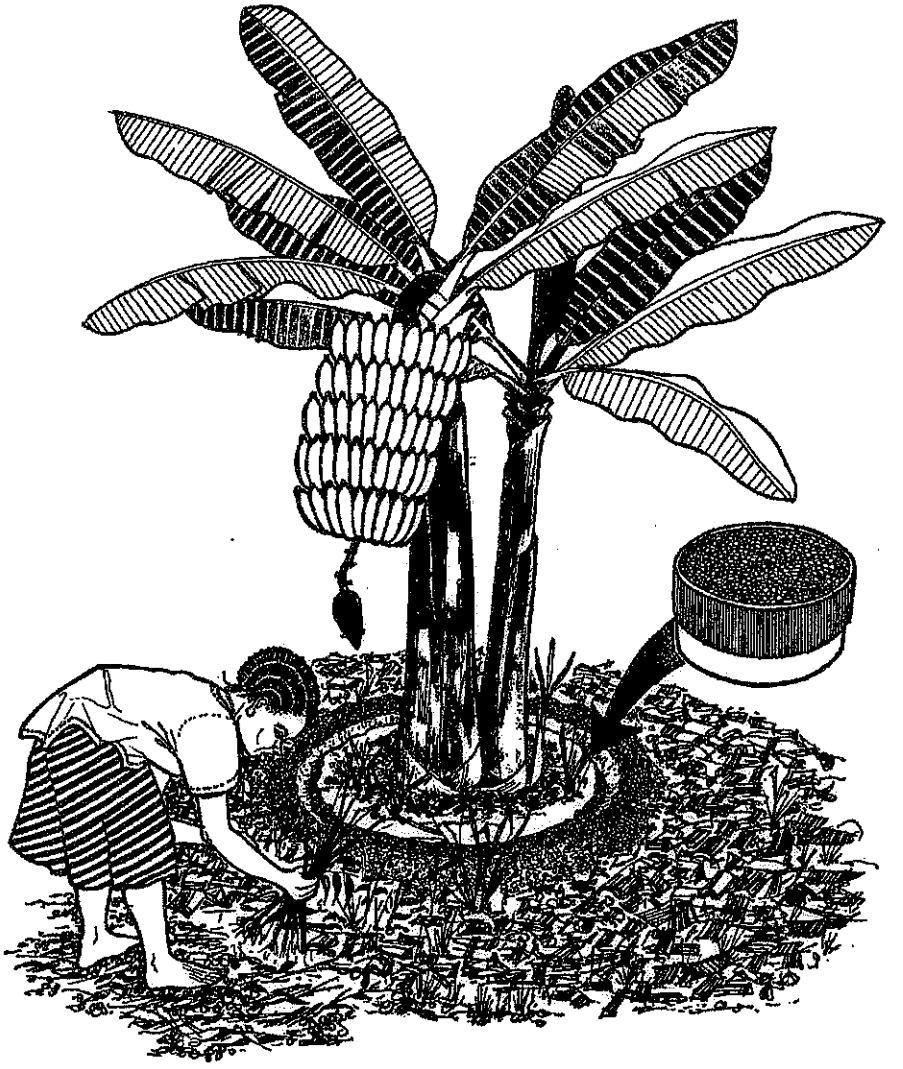
BANANA PRODUCTION MANUAL



A guide to successful banana production in Uganda.

NARO

ADC
IDEA PROJECT

BANANA PRODUCTION MANUAL: A guide to successful banana production in Uganda.

Editors:
Wilberforce K. Tushemereirwe
Imelda N. Kashaija
William Tinzaara
Caroline Nankinga
Stephen New

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FORWARD

The banana is one of the most important food security and cash crops in Uganda. Areas of the country where banana is the main staple experience less famine. This is because the crop's all-year-round fruiting habit coupled with high yield ensures continuous supply of food. For a long time, the crop was believed to be hardy and able to continue growing well in Uganda as long as the nutrient levels in the plantations were adequate.

However, the crop has been losing ground because of a complex of problems including soil fertility decline, pest/disease build-up and socio-economic problems. In recent years, drastic yield decline in the traditional banana growing areas of central Uganda has led to a replacement of bananas with annual crops. Annual crops require more elaborate phasing or storage in order to have food all the year round. Many farmers in the areas where bananas have lost sustainability appear unable to cope with the storage requirements of annual crops hence they are facing frequent food shortage crises. Displacement of bananas in farming systems poses a serious threat to food security, the environment and general welfare of the people in the affected area.

In the past, banana was a highly sustainable crop in Uganda, with long plantation life and stable yields. Indeed in some areas, gardens of 50-100 years still exist. However, the frequency of replanting in central Uganda is currently as short as 5 -10 years.

Reversing the banana productivity decline and increasing plantation life in traditional banana growing areas are big challenges to the Country, for which the Uganda National Banana Research Programme (UNBRP) was created (1989). With assistance from the International Development Research Centre (IDRC), the Rockefeller Foundation, the Department for International Development (DFID) and United States Agency for International Development (USAID), for which I am grateful, the programme has since generated a lot of information that could go a long way in alleviating banana production problems if applied by the producers. The challenge is to get the information to the producers.

This manual has attempted to package the latest knowledge NARO would like banana producers to try. The manual summarises the information our scientists have been giving to the farmers and other stakeholders who seek latest information about banana production and utilisation. It has been made simple enough for all those involved in dissemination of agricultural information to understand. Farmers who read and understand the English language will be able to use it. It is hoped that the extension workers and banana farmers will find it useful. The assistance from USAID funded

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Prof. J. K. Mukiibi
Director General
National Agricultural Research Organisation (NARO)

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LIST OF ABBREVIATIONS

ADC	Agribusiness Development Centre
IDEA	Investment in Developing Export Agriculture
KARI	Kawanda Agricultural Research Institute
NARO	National Agricultural Research 0rganization
NBRP	National Banana Research Programme
Mg	Magnesium
ha	hectare
m.a.s.l.	metre above sea level
FHIA	Foundacion Hondurena Internationalo Agricola
g	grams
Kg	Kilograms
ppm	parts per million
P	Phosphorus
NPK	Nitrogen, Phosphorus, Potassium
CAN	Calcium Ammonium Nitrate
DAP	Diammonium Phosphate
SSP	Single Super Phosphate
TSP	Triple Super Phosphate

CONTENTS

1.0 INTRODUCTION

Bananas/plantains rank highest amongst the most important food crops in Uganda. Annual production is currently estimated at 8.45 million tons, accounting for 15% of total world banana/plantain output. In Uganda, over 7 million people including 65% of the urban population depend on the crop as their staple. It is estimated that 75% of the farmers grow the crop on 1.3 million hectares.

Most of this production is for local consumption, the country having the highest consumption rate worldwide (per capita consumption 450kg). In addition to providing food, bananas ensure income to the farmer throughout the year, play a key role in import substitution, provide soil surface cover, reduce soil erosion on steep slopes and are a principal source of mulch for maintaining soil fertility and improving penetration of water into the soil. Bananas also provide feeds for animals. Besides, there is a socio-economic culture based on the banana crop.

In spite of its economic importance, the banana is currently under threat posed by constraints such as declining soil fertility, pests and diseases. This manual outlines key management practices used in the growing of bananas. It has been written as a reference source suitable for technicians, extensionists as well as banana producers.

2.0 BANANA PLANTATION ESTABLISHMENT

2.1 Requirements

Climate
Bananas grow best in areas with an optimal mean monthly temperature of 27°C. The lowest mean annual temperature for growth is 12°C and temperatures beyond 37°C can cause leaf scorching. They have a high water demand, with approximately 25 mm per week being the minimum for optimum growth. An average annual rainfall of 1500-2500 mm, which is well distributed is considered the most optimal. However, with good management of available water, bananas can even grow in areas with mean annual rainfall lower than 1200 mm.

Soil requirement
Bananas require a deep, well-drained loam soil with high humus content. A pH range of 5.6 - 7.5 is optimum. Bananas require considerable amounts of Nitrogen, and Potassium (NK) to maintain high yields. These can be supplied by planting on fertile soils or applying fertilisers regularly (see sections 3.3.1, 3.3.2, and 3.3.3).

2.2 Preparing the field

If the plantation is to be established on fallow land (3 to 5 years), the field should be slashed and left without being burned. Burning is not usually recommended because useful organic matter is destroyed. Alternatively, spray with herbicides Gramoxone or Roundup (see section 3.1.2).

Generally two ploughings are sufficient to provide a good seedbed for the banana plantation. About four weeks should be left between each cultivation to allow germination of weed seeds that are then killed by the following cultivation. However, planting holes may be made directly in cleared land. The successive weeds are then cleared with hoe or herbicides weeding.

2.3 Spacing and hole size

The recommended spacing is 3m between and 3m within the row (3m x 3m). Rows should be straight in flat fields to allow plants to receive maximum amount of sunlight. On sloping land, rows should follow the contour lines in order to decrease soil erosion.

To avoid early emergency of a high mat, dig holes that are 45cm deep and 45cm wide. Generally, plant hole size ranges from 30 - 60 cm deep and wide. Making holes bigger than 60 cm may not be worth the labour (not cost effective).

2.4 Planting Material

2.4.1 Source

The planting material should be obtained from healthy plantations (free of soil borne-diseases and pests). All planting materials should first be treated (see section 2.4.4 and 4.1.2) to remove or kill pests in the corm and roots. Micropropagated plants (tissue culture plants) are the best alternative for pest/disease free planting material.

Tissue cultured plants can be obtained from the National Banana Research Programme (NBRP) at Kawanda Agricultural Research Institute (KARI). Meanwhile, mother gardens are being raised in various districts to provide healthy plantations for supply of clean suckers to farmers.

2.4.2 Cultivars

A number of banana cultivars exist in Uganda, some being landraces (Plate 1a) and others exotic (Plate 1b). Landrace refers to the traditional cooking (Matooke) and beer (Mbiide) bananas. They are also called the East African Highland or local bananas, and are endemic in the region.

Plate 1a. East African Highland (or Local banana cultivars)

Plate 1b. Exotic banana cultivars (early introductions)

Sukari - Ndiizi	Bogoya	Kayiinja
(Apple Banana)	(Gros Michel)	(Pisang Awak)

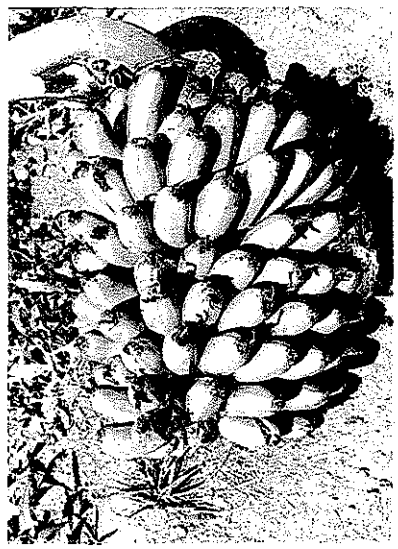
Plate 2. Representative cultivars/clones for each of the five clone sets.

Musakala Clone set: clone Mudwale, showing the bunch of long slender and bottle-necked fruits.

Nakabululu clone set: clone Bifusi, showing the subhorizontal compact and short bunch of short rounded fruit

Nakitembe clone set: clone Mbwazirume (immature), showing the persistent style on fruits, the persistent neuter flowers along the male rachis and the male bud.

Nfuuka clone set: clone Enyeru, showing the rectangular and compact bunch, with medium fruit not strongly recurved towards the rachis.



Beer clone set: clone Namadhi, showing the inflated fruits with blunt apices and persistent dry styles.

In each group or clone set, some cultivars are preferred over others, and preference varies from one place to another. Although the criteria for cultivar preference also varies among farmers and/or locations, characteristics that give a bunch a good market value are considered first. Generally the most preferred cultivars include those, which have one or a combination of more than one of the following characteristics: big bunch, compact bunch, medium size fruits and tasty food.

A number of Matooke cultivars that have the above mentioned qualities have been identified by the National Banana Research Programme, which promotes their distribution and cultivation countrywide through its germplasm multiplication and dissemination project. These cultivars include Kisansa, Musakala, Mudwale Namaliga, Mbwazilume, Nakitembe, Ndibwabalangira, Ntika, Kibuzi, Wansimirahi, Nakibizi, Mayovu and Nyamasharira.

All the other banana types imported into the country long after existence of the traditional types are referred to as exotic. They include early introductions like Bogoya, Ndiizi, Kayinja (Plate 1b), Kisubi and Kivuvu, and recent introductions like FHIA 01, FHIA 03 Kabana 1, FHIA 17 Kabana 2, FHIA 21, FHIA 23 Kabana 4, and Km5 as shown in Plate 3.

Plate 3. Recent introductions under final evaluation by farmers

Kabana 1 (came in as FHIA 01)

Kabana 2 (came in as FHIA 03)

FHIA 17 (Will be called Kabana3 when officially released)

FHIA 23 (will be called Kabana 4)

Yangambi KM5 (will be called Kabana 5)

FHIA 21

The local cultivars have been found to fall into five different groups referred to as clone sets as indicated below:

Musakala clone set- Members have big bunches with loosely packed clusters. They are currently the most preferred commercially. They include Muvubo, Musakala, Mayovu, Mudwale, and Muturit.

Nakitembe clone set- Cultivars in here have compact bunches of medium fruit size. A few clones have big bunches and are also liked commercially. They are fast maturing and very tasty. They include Nakitembe, Nakitembe Nakamali, Nakitembe Nakawere, Nalwera, Waikova, Enjagata, Nasaala, and Oruhuuna.

Nakabululu clone set- These have very compact bunches of very short fruits. They put on small bunches but are fast maturing and very tasty. They include Nakabululu, Kazirakwe, Butobe, and Mukite.

Nfuuka clone set- This consists of clones of mixed characteristics. The bunches are compact and fruits medium in size. They produce big bunches that are commercial. They are slow maturing and is not very tasty. They include Entukura, Nassaba, Nzirabushera, Entazinduka, Nakinyika, Enyeru, Lusumba Kasenene, Namakhumbu, Bukumu, and Nambokho.

Mbiide (beer banana) clone set- Cultivars are similar to matooke types but these are bitter and astringent even when mature. They include Namadhi, Nalukila, Entanga Engambani, Engumba, and Oruhuuna.

Note that one clone /cultivar can have more than one name, which varies from place to place. A list of synonyms of the above mentioned cultivars is available at Kawanda. Examples of cultivars for each clone set are shown in Plate 2.

The first four groups consist of exclusively cooking bananas (matooke) while the fifth group consists of cultivars used for making juice/beer. They, however, can be cooked during famine periods.

Through farmer participatory evaluation, the recently introduced cultivars have beer found to have many uses as indicated in Table 1.

Table 1. New (recent introductions) cultivars and their uses.

CULTIVAR	USE(S) in order of preference	REMARK(S)
Kabana 1 (FHIA 01)	• Cooked/boiled green • Eaten as a dessert when ripe • Fried when ripe or green for crisp • Baked when ripe or green • Juice extraction	This cultivar is not a "matooke" type. Therefore it cannot taste exactly like the local "matooke" bananas. It is also not as soft as traditionally preferred. Treat it as a "new product".
Kabana 2 (FHIA 03)	• Juice extraction • Fried when ripe or green for crisp • Baked when ripe • As a dessert when ripe	Gives high juice yields. Juice sugar content is comparable to that of local cultivars Mbidde). Gives very tasty crisp when ripe.
FHIA 17 [Kabana 3]	• As a dessert when ripe • Cooked/boiled green • Fried when ripe or green for crisp • Baked when ripe or green	A very good dessert. Favourably competes with Bogoya in taste.
FHIA 23 [Kabana 4]	• As a dessert when ripe • Cooked/boiled green • Fried when ripe or green for crisp • Baked when ripe or green	A very good dessert has good taste when cooked.
Yangambi KM5 [Kabana 5]	• Juice extraction • As a dessert when ripe • Fried when ripe or green for crisp • Cooked/boiled green	Juice yield and sugar content equal to that of Mbidde. In this regard, the two are not as good as FHIA 03.
FHIA 21	• Roasted when half/full ripe • Fried when ripe or green for crisp • Baked when ripe	A very good plantain (Gonja-like).

Of these cultivars FHIA 01 and FHIA 03 have been officially released under new names as Kabana 1 and Kabana 2 respectively for distribution to farmers while the rest are under farmer participatory evaluation. Applications for release of FHIA 17, FHIA 23 and Yangambi KM5 has been submitted and when cleared they will be released under the new names indicated in brackets.

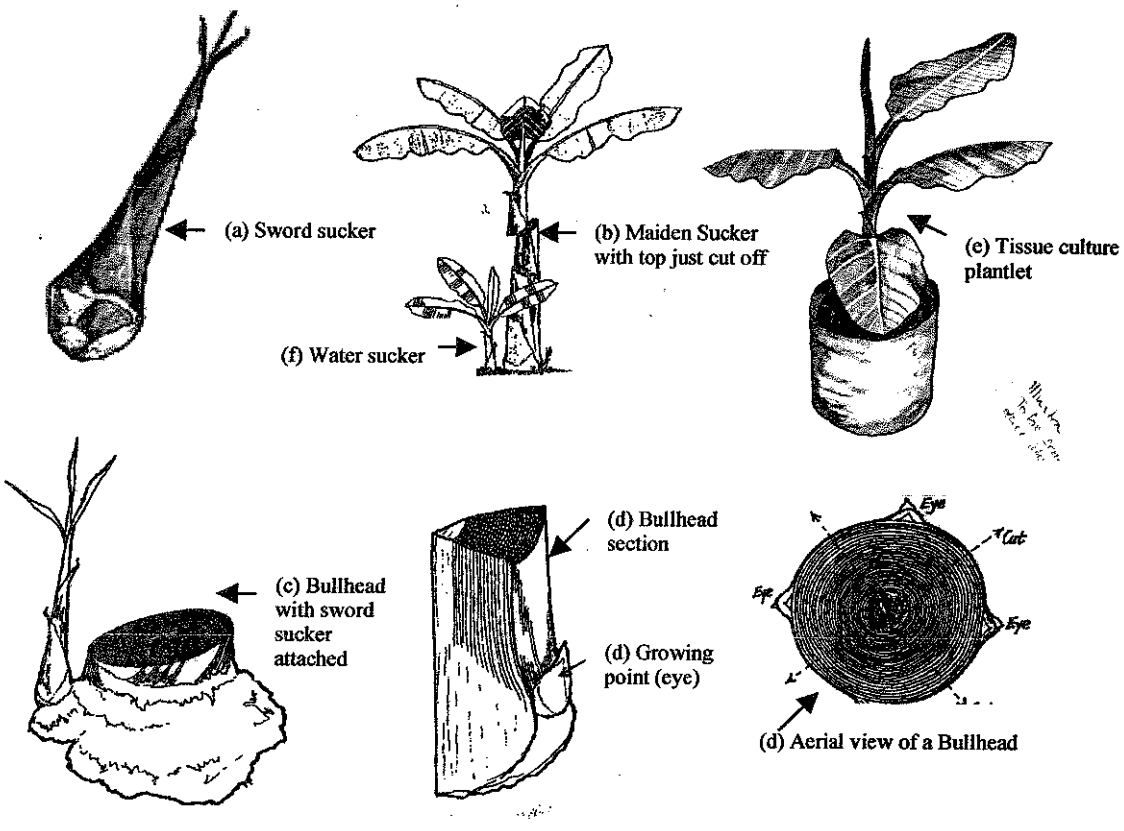
The Kabana 1 (FHIA 01) cultivar has been identified (by farmers in Luwero) as a good cooking type. The new cultivars or hybrids are resistant/tolerant to most or all pests, diseases and stress conditions to which the local cultivars easily succumb. Introduction, development and testing of new materials is continuing.

2.4.3 Types of planting material

Below is a list of different forms of planting material including the few that are currently recommended in Uganda. The types are shown in figure 1

a) Sword sucker (sucker 30 - 100 cm high and with narrow leaves)
b) Maiden sucker (about 2 m high, and not yet flowered) or its corm.
c) Bullhead (corm from a plant which has been harvested) with or without a sword sucker
d) Bullhead sections (corm pieces with a bud/eye)
e) Tissue culture plantlets

Figure 1. Different types of planting material



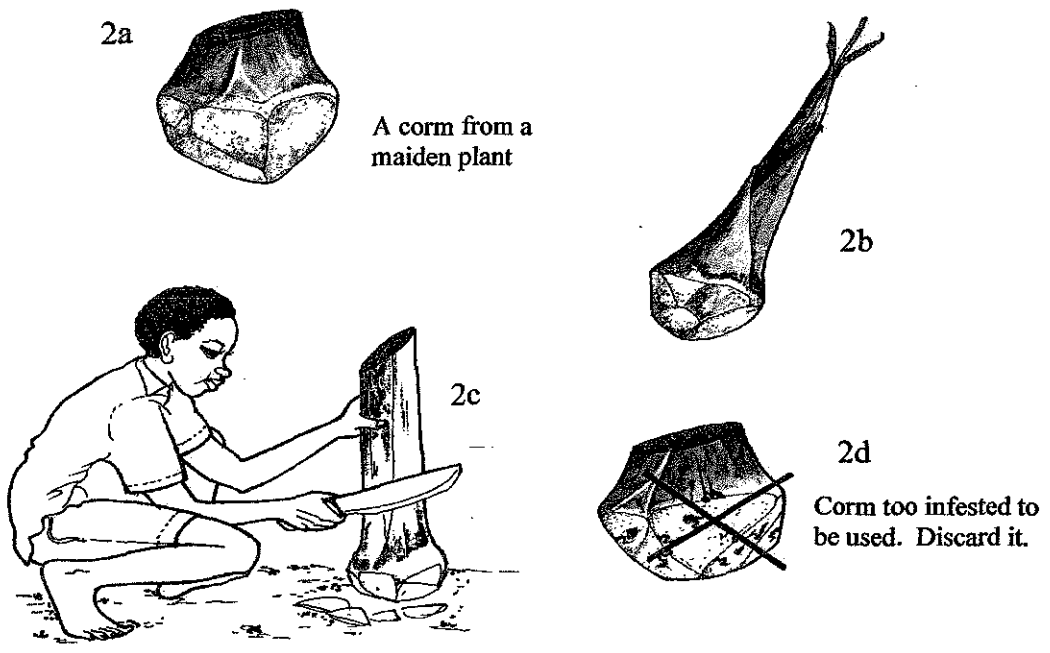
Sword suckers, maiden suckers and tissue culture plantlets are the ones most recommended currently. Avoid water suckers (field suckers with broad leaves) shown in figure 1f.

2.4.4 **Preparation of Planting Material**

Uproot a selected sucker using a very sharp shovel to reduce damage to the mother plant. If it is a maiden sucker cut it back just below the crown. If a lot of planting material is needed and is collected from far, the maiden sucker may be cut at about 15 cm above the corm - pseudostem joint (Figure 2a) to reduce bulk. Sword suckers (Figure 2b) should

not be cut back. To avoid taking weevils and /or nematodes to new fields all roots and the outer layer of the corm, and old leaf sheaths should be peeled off (Figure 2c). Try to remove all tunnels (formed by weevil larvae) and reddish-brown or black tissues (necrosis due to nematodes). If the tunnels go deep into the corm (Figure 2d), then such a sucker should be discarded for it may be carrying weevil larvae inside the tunnels. Cleaning of suckers should be carried out in the field where the planting material is obtained to avoid contamination of the new field with the pests.

Figure 2. Preparing, cleaning and sorting planting materials



As an additional treatment, pared suckers can be dipped in hot water at a temperature between 52°C and 55°C for 20 minutes or in a pesticide solution to kill the deeply embedded pests (See section 4.1.2 for details).

For better germination, it is advisable to plant the treated/cleaned planting material within a week of uprooting. If there is need to store them temporarily, they should be kept in shade (never exposed directly in the sun) and away from an established plantation as the latter may be infested with weevils. The weevils may attack and lay eggs on the cleaned material before it is planted.

2.5 Planting

Planting should be done at the beginning of a rainy season, as banana suckers need 4-6 months of growth without water stress. The sucker is placed in the hole and its corm is covered, first with the topsoil, mixed with manure and then topped up with the subsoil. If the land is sloping, the sucker should be so oriented that the future ratoon emerges against the slope. This will delay development of high mat.

Note: If the planting materials were not cleaned further with a pesticide, you may apply insecticides or nematicides in the hole and on top of the soil after planting, using recommended manufacturers' rates.

3.0 PLANTATION MANAGEMENT.

3.1 Weed Control

Weeds compete with the banana plants for nutrients and water. This may lead to stunte growth of plants. Banana plantations must therefore always be kept weed free Different methods exist for controlling weeds and their suitability depends on the age o the plantation and availability of labour/funds. They include weeding by hand, hoe an herbicide.

3.1.1 Hand weeding

If weeding is by hand, the weed residues should be heaped together in the plantation sc as to confine the weed seeds in one or a few places. Although it is laborious, hand weeding is better than hoe weeding as it is less destructive to the delicate banana roots and soil structure. It is however most applicable where weed density is very low, such as in mulched plantations. Otherwise, high-density weeds can be removed faster by hoe weeding and fastest by spraying with a herbicide. Note that hoe weeding is not recommended because of the damage it causes to the feeder roots.

3.1.2 Herbicides use

Using chemical herbicides is one of the cheapest means of controlling weeds. In Uganda herbicides are obtained as concentrated liquids which are then mixed in water at recommended rates and applied to the weeds using a knapsack sprayer. When spraying, precautions must be taken to avoid herbicide drift to the banana plants. For example, young/short suckers can be covered with polythene bags as one sprays. They should then be uncovered quickly after spraying the nearby lines. If possible avoid spraying on a day with high winds. Do not spray immediately after rain. Let at least three hours elapse before you begin spraying. Herbicides commonly used in Uganda include Gramoxone and Roundup. Table 2 can help you to select the appropriate herbicide for the weeds in your field.

Note that the rate (amount of herbicide to mix with water in a sprayer pump) may change according to grass type, age and thickness. The table gives recommendations assuming that the weeds are sprayed at the right stage. Farmers are advised to contact extension workers or crop chemical agents and stockists for details.

Table 2. Appropriate herbicide and rate for various weed types

Type of weed	**Appropriate Herbicide**	**Amount of herbicide per 15 litres of pump**	**Amount of herbicide /ha**
Kikuyu grass *Pennisetimu clandestinum*	Round up (36% glyphosate)	260 mls	3.5 litres
	Touchdown (33% glyphosate trimesium)	220 mls	3.0 litres
(Lumbugu) Couch grass in the cool highlands *Digitaria abyssinica*	Round up	300 mls	4 litres
	Touchdown	260 mls	3.5 litres
Digitaria abyssinica (Lumbugu) in the lowlands	Round up	330-480 mls	4.5 – 6.5 litres
	Touchdown	300 mls	4 litres
Star grass or *Cynodon dactylon* Spear grass or *Imperata cylindrica, Paspalum conjugatum*	Roundup	630 mls	8.5 litres
	Touchdown	480 mls	6.5 litres
Sedges or *Cyperus* spp.	Roundup	520 mls	7.0 litres
	Touchdown	330 mls	4.5 litres
Commelina benghalensis	Roundup	600 mls	8.0 litres
	Touchdown	450 mls	6.0 litres
Annual weeds mainly the Composite and Amaranthaceae such as Goat weed - *Ageratum conyzoides*, Galland soldier - *Galinsoga parviflora*, black jack-*Bidens pilosa*, Pig weed – *Amaranthus* spp.	Roundup	66 mls	1.0 litre
	Basta (20% glufosinate ammonium)	100-250 mls	2-5 litres

N.B. For Roundup and Touchdown use 200 litres of spray per hectare. For Basta use 300 litres of spray per hactare.

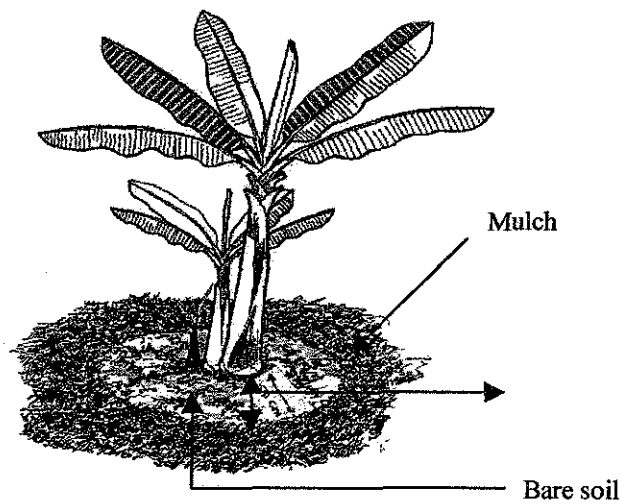
3.2 Mulching

Mulching reduces the amount of weeds in a plantation by choking the established weeds and denying light to those that require it for germination. Additionally, mulch helps water to penetrate deeper into the soil and it prolongs its retention. It also returns nutrients to soil as it rots, thus improving soil fertility. The following are some of the sources of mulch:

- Banana plant residues. When leaves get old (senescent) prune them off and spread them between rows of the banana plants also split pseudostems of harvested, pruned and toppled plants and place them between rows.
- Annual crop residues, e.g. maize stover, bean trash, etc..
- Grasses, e.g. elephant grass, swamp grass, Guatemala grass and Guinea grass (chopped and dried).

Farmers should note that mulching sometimes provides good homes for pests such as the banana weevil. Mulches should therefore be placed away from the base of the mat so as to reduce the population of weevils that may get in contact with the plants. The recommended distance is 50 cm (1.7ft) from the mat.

Figure 3. Mulch placement – away from plants



3.3 Plant nutrition

As a plant grows it takes up nutrients from soil. A large amount of the nutrients taken up from soil by a banana plant goes into the fruits (bunch). Most of the banana fruits are sold to urban centres and they go with the nutrients especially in the peel. So the only way to maintain soil fertility is by regularly or continuously putting back nutrients in form of fertiliser (organic, inorganic). If fertility is not maintained in this way, even the most fertile soils will gradually become unproductive. Bananas have a high demand for nitrogen (N) and potassium (K). Phosphorus (P) magnesium (Mg) and calcium (Ca) are vital but required in small quantities. These nutrient elements play different roles. Nitrogen contributes to growth of a banana plant as a whole and keeps leaves green and healthy thus able to capture more sunlight to make more food/big bunches. Phosphorus helps the banana plant to have strong and healthy roots that will capture more water and nutrients in the soil. Potassium helps in moving the food and water from roots to leaves and bunches. Magnesium helps the leaves to use the sunlight captured to make food.

Farmers commonly use farmyard or compost manure. Well rotted manure may be placed in planting holes or on the soil surface.

3.3.1 Organic fertiliser sources

The following are some of the organic materials that provide essential nutrients.

- Crop residues e.g. bean hulls and stalks, maize, sorghum and millet stover,
- Other plant residues e.g. swamp and elephant grass (chopped and dried)
- Animal waste e.g. cow and chicken manure

The above materials can be applied individually and directly or can be combined and composted. Mature compost manure is mixed with soil and placed in a planting hole at planting. In established plantations it may be placed on the soil surface in a ring or furrows 45 cm (1.5 ft) from a mat or be ploughed in the soil.

3.3.2 Types of inorganic fertiliser and nutrients they provide

One nutrient element can be provided by different types of fertilisers found on the market. Table 2 shows the commonly used fertilisers and the nutrients they supply. The rate of application depends on the rate at which the nutrient is removed from soil. Some nutrients leach very quickly when it rains. Such nutrients therefore need to be added more often but in small quantities as shown in table 2.

Table 3. Important nutrients, sources and application rates for better banana production

Nutrient	Fertiliser that provides it	Amount per stool	Number of times to apply it in a year
N	Urea, DAP	75 g	4 times
K	Muriate of potash (KCl)	85g	2 times

Note: 85g of fertiliser is about quarter of a large plastic drinking cup

3.3.3. Fertiliser application

As shown in figure 4, remove trash and make a ring about 30cm (1ft) away from the stool. Sprinkle and spread the measured amount of fertilizer in the ring. Cover the fertilizer with soil but do not work it (dig it) in the soil, because you may cause damage to the superficial roots of the banana plant.

3.3.4 Nutrient deficiency symptoms

Nitrogen (N)

Appearance of nitrogen deficiency symptoms is quick and rapidly covers leaves of all ages. The symptoms are:

1. Leaves become very small and are pale green
2. Mid-rib, petioles and leaf sheaths become reddish pink in colour
3. The rate at which leaves are produced decreases
4. Distance between successive leaves is reduced giving the plant a 'rosette appearance'
5. Growth is poor leading to a stunted plant
6. Banana bunches become small

Potassium (K)

Symptoms of potassium deficiency normally appear at the time of the flowering. They include:

1. Rapid appearance of orange / yellow colour on the older leaves and their subsequent drying and death.
2. The mid-rib of these leaves are very often bent or broken at two-thirds distance along its length so that the leaf points towards the base of the plant.
3. Plants produce small leaves
4. Delayed flowering
5. Reduced bunch sizes

Phosphorus (P)

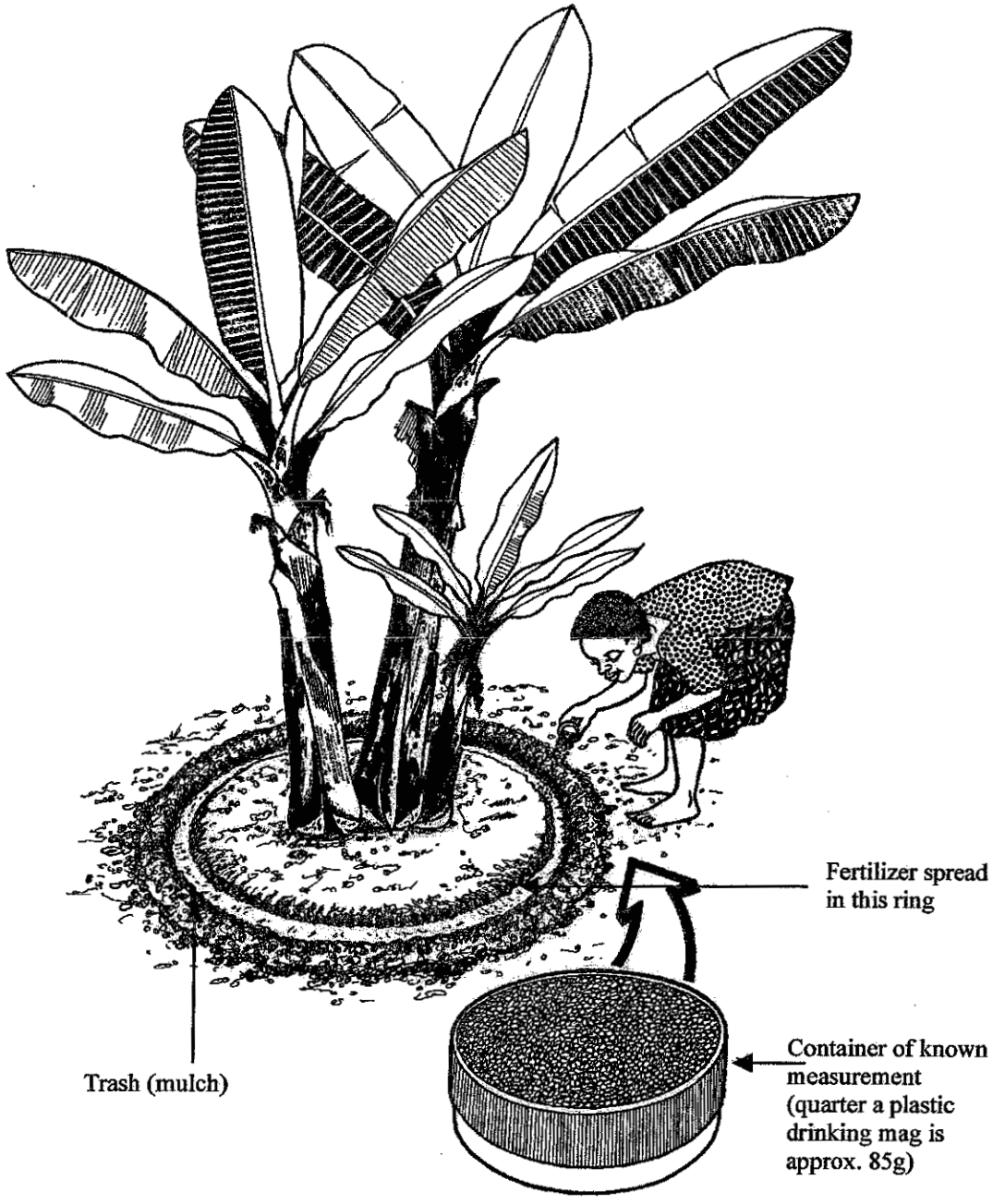
Deficiency symptoms of phosphorus are rarely seen in the field. They however include:

1. Stunted growth and poor root development.
2. In the older four or five leaves, the leaf margins (edges) lose their colour (chlorosis). Then purple brown flecks develop that eventually combine to produce 'sawtooth' necrosis (dying) of the leaf edges.
3. Affected leaves curl and the petioles break.
4. Young leaves have a deep bluish green colour.

Magnesium (Mg)

1. Yellowing of leaf margins of older leaves, the yellowing extends towards the mid-rib, with a green band remaining near the mid-rib.
2. The yellowing (chlorosis) is more severe where the leaf's exposed to the sun.
3. Purple mottling of the petioles.
4. Separation of leaf sheath from pseudostem.

Figure 4. Application of fertilizer in a banana plantation



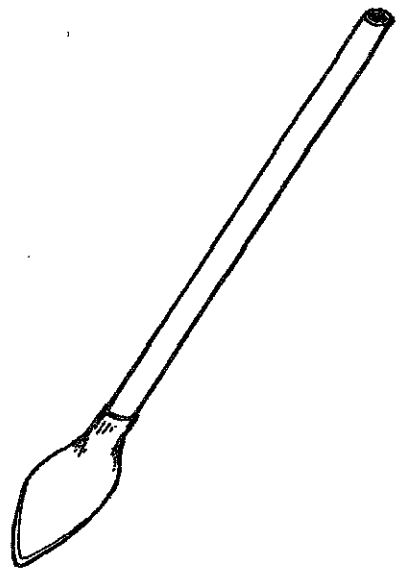
3.4 Sucker removal and mat management

Sucker removal is carried out to maintain the appropriate plant density and ensure that the number of bunch bearing plants is maintained at a level which reduces competition (for water, light, nutrients) and gives high yield. Farmers are advised to maintain 3 plants on each mat; a mother, one daughter and one grand daughter. That is, only one sucker from each successive generation is allowed to grow. It is better to select easterly facing suckers to maximise on morning sunshine unless the plantation is on a slope. While pruning make sure that the growing point of the unwanted sucker is killed. This is best done by using a spear-like tool. Cutting off the sucker at ground level is not effective as the sucker will grow again. The growing point is in the corm at about 5 - 10 cm below the ground. To kill it the sucker's pseudostem is cut off near its corm and the pointed tool (Figure 5) is twisted in the growing point, thus killing it.

3.5 Leaf removal

Leaf removal is important for maintaining plantation hygiene and light penetration. Dead hanging leaves cover young suckers while old sheaths on the base of pseudostem provide a home for adult banana weevils. The non-functional leaves also reduce air movement around plants thus encouraging high humidity build up. Therefore old leaves and sheaths should be removed and can be used as mulch. Note that only those leaves whose green part is less than 50% should be cut off. The plant should be left with at least 9 functional leaves at flowering and should be having at least 4 leaves at harvest. Complete removal of leaves from the plant prior to harvesting is not recommended, as it will start the ripening process prematurely.

Figure 5. A tool for removing



3.6 Bud removal

The male bud should be removed when the peduncle is at least 15 cm below the last female hand or when the fingers on clusters just turn upwards. Break/cut the peduncle 15 cm below the false cluster/hand taking care not to damage the fingers. Bud removal helps to reduce fruit diseases like cigar end rot, which are transmitted by insects that visit the bud bracts and leads to bigger banana fingers in some cultivars (e.g. FHIA 21).

3.7 Propping

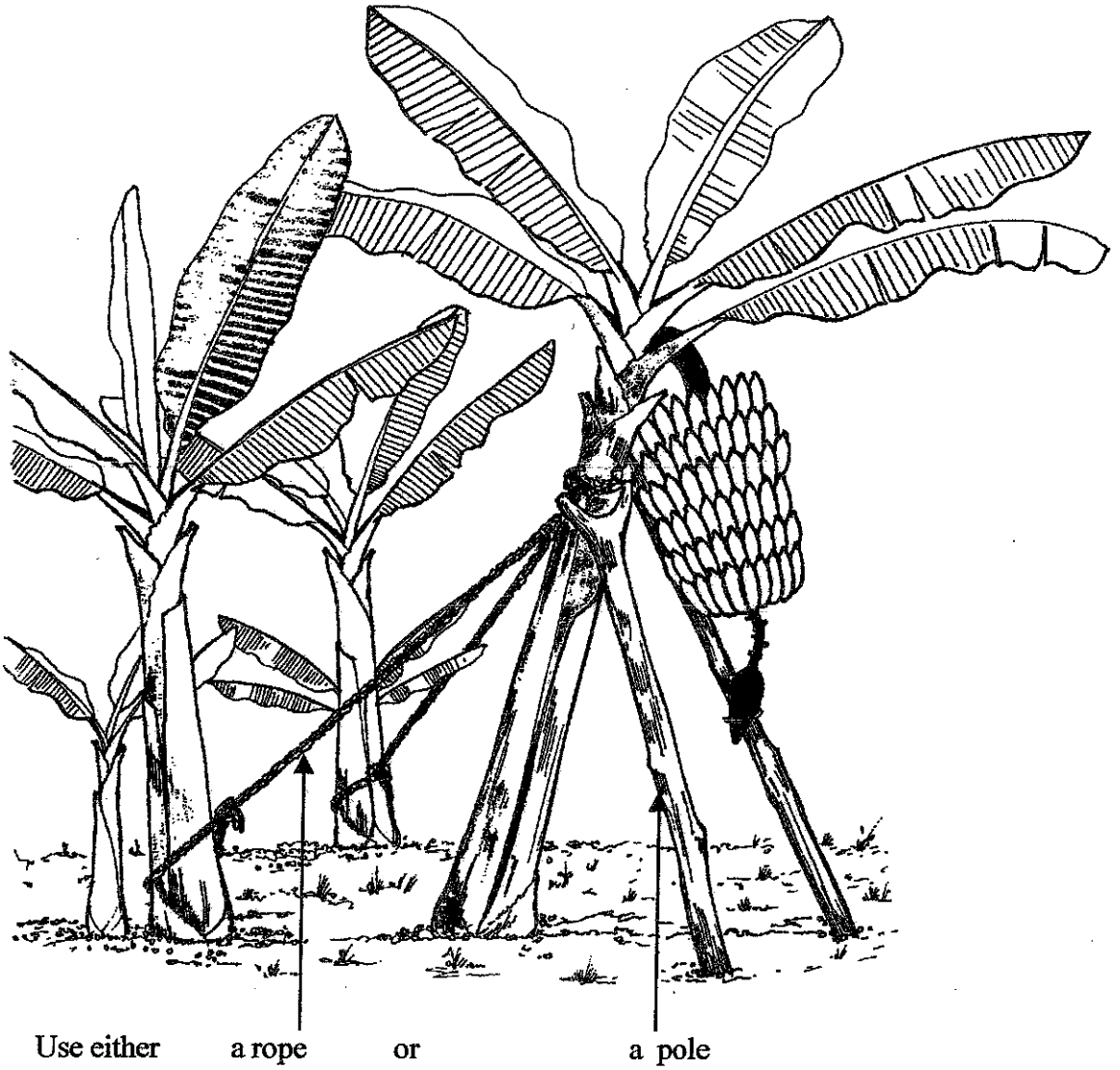
Propping/guying up of banana is done in order to prevent the plants with maturing bunches from breaking or toppling. The heavy weight of the banana bunch bends the bearing plant and can cause doubling (pseudostem breaks), snap-off (corm breaks, leaving a part in the ground) or uprooting, also called toppling (the entire corm with roots comes out of the ground).

Plants are generally weak during the dry season. Strong winds, nematodes and weevils also increase the chances and/or rate of plant toppling. For these reasons, bearing plants, especially those with heavy bunches, always need support. Either wooden pegs (poles) or ropes can be used as shown in Figure 6.

3.8 Intercropping

In areas where rainfall is high, you can inter-crop beans, coffee, green vegetable etc. with out much loss in banana production. However, it is important to give each crop its right spacing. It is noted that intercropping, especially in newly planted fields, has some advantage in that the land gives a return before the banana crop is ready for harvest. It is best not to inter-crop green manures such as tephrosia, mucuna and canavalia in banana. Green manures and other inappropriate intercrops compete with banana for nutrients and water, which may lead to soil exhaustion and plant health problems.

Figure 6. Supporting of fruit-bearing plants: either ropes or poles are used.



3.9 Soil and water conservation measures

Fanya juu

If your banana plantation is on a steep slope, make fanya juus (Figure 7). That is, dig trenches 60 cm (2 ft) wide and 60 cm 2 ft deep across the slope putting soil on the upper side of the trench. These should be 10 to 20 paces apart. Fanya juus prevent the washing away of soil down the slope when it rains. They also increase the amount of water entering the soil. The same (preventing soil erosion and increasing water entering the soil) can be achieved by use of grass bands. Vetiver grass is recommended for this, as it does not compete with the bananas for nutrients. Grass (vetiver) can also be grown on the fanya juu to stabilize it.

Figure 7. Fanya juu

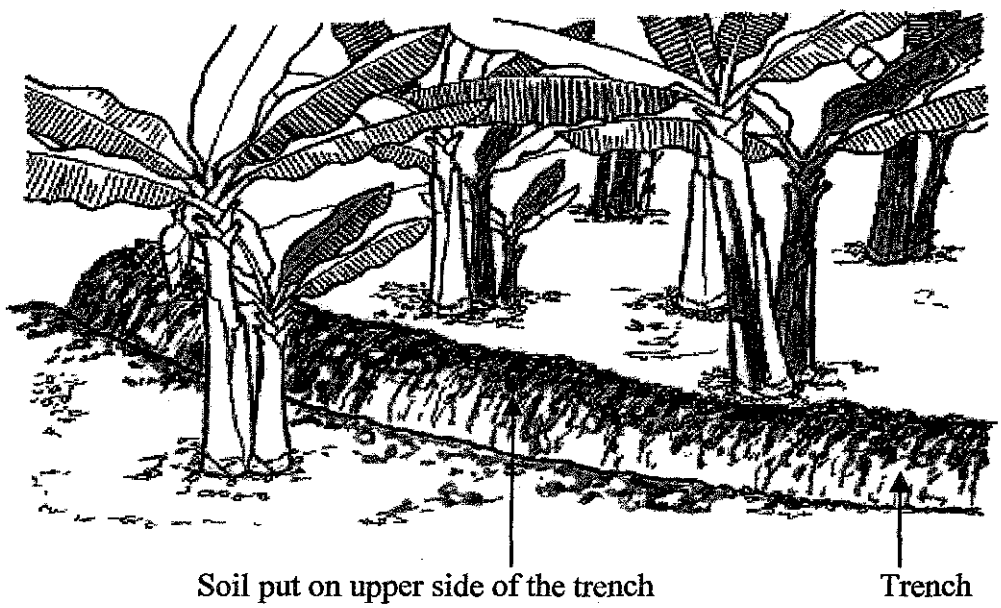
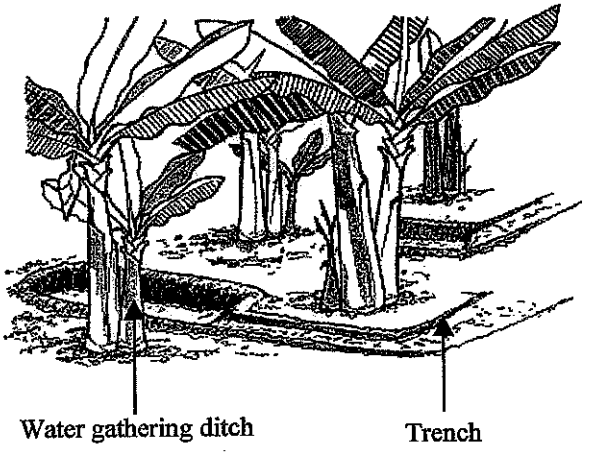


Plate 4. Vetiver grass used as a band for soil and water conservation in a banana field.

Water retention ditches

Dig ditches or trenches in your plantation to hold rainwater flowing down a slope. This increases the amount of rainwater entering the soil and reduces soil erosion.

Figure 8. Water retention ditches



4.0 PEST CONTROL

The banana weevil and plant parasitic nematodes are the most destructive pests of bananas in Uganda. These pests may cause severe yield loss if not controlled.

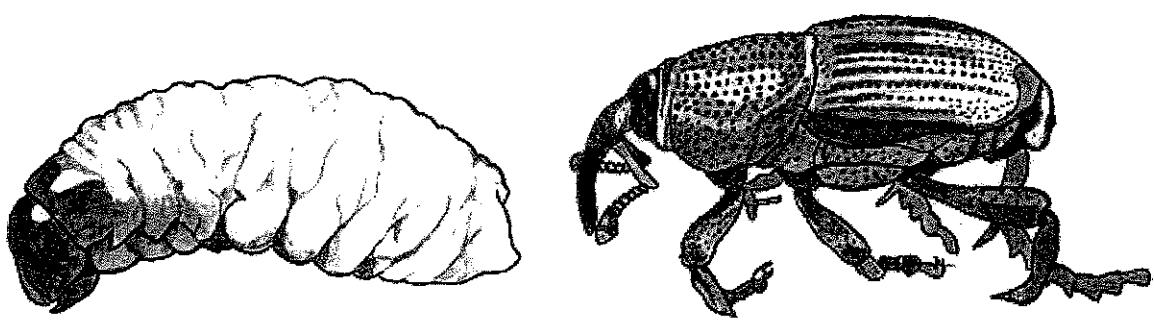
4.1 Banana Weevil

4.1.1 Banana Weevil damage and symptoms

Weevil damage results from larvae (Figure 9a) feeding and tunnelling into banana corms and pseudostems. The larvae hatches from an egg which is laid near the corm by an adult weevil (Figure 9b). On hatching the larvae attack the underground part, boring tunnels in it. As weevil larvae grow in size, they make large tunnels in the corm and sometimes up in the pseudostem (Figure 10). The damage interferes with uptake of nutrients and water thus weakening the plant.

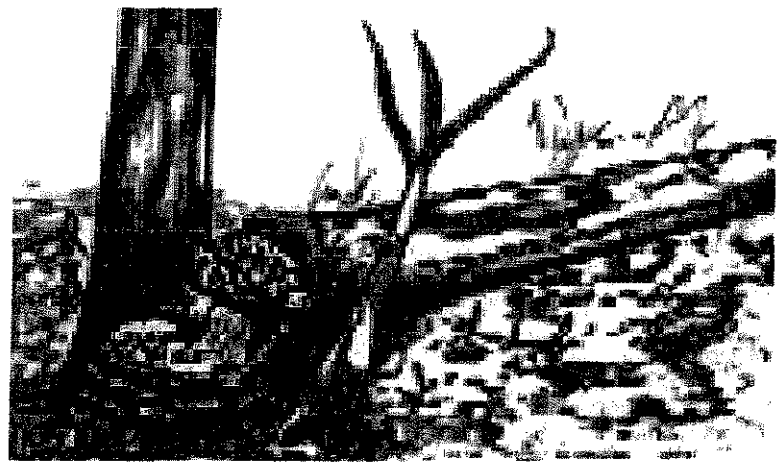
Weevil infestation of young plants causes stunting of growth, disruption and delay of fruiting, production of small bunches and sometimes plants death. Heavily infested and damaged plants easily snap (breaking of pseudostem just above the ground as shown (figure 10) under a mild wind, especially flowered plants. The banana weevil causes more damage to the local matooke types than the exotic cultivars, and is more severe at lower altitudes (1000 - 1200 m.a.s.l.) than higher altitudes (>1500 m.a.s.l.)

Figure 9. The banana weevil larva (a) and adult (b)



(a) *Banana Weevil Larva* (b) *Adult Banana Weevil*

Figure 10. A snapped corm with tunnels inside; a symptom of weevil damage



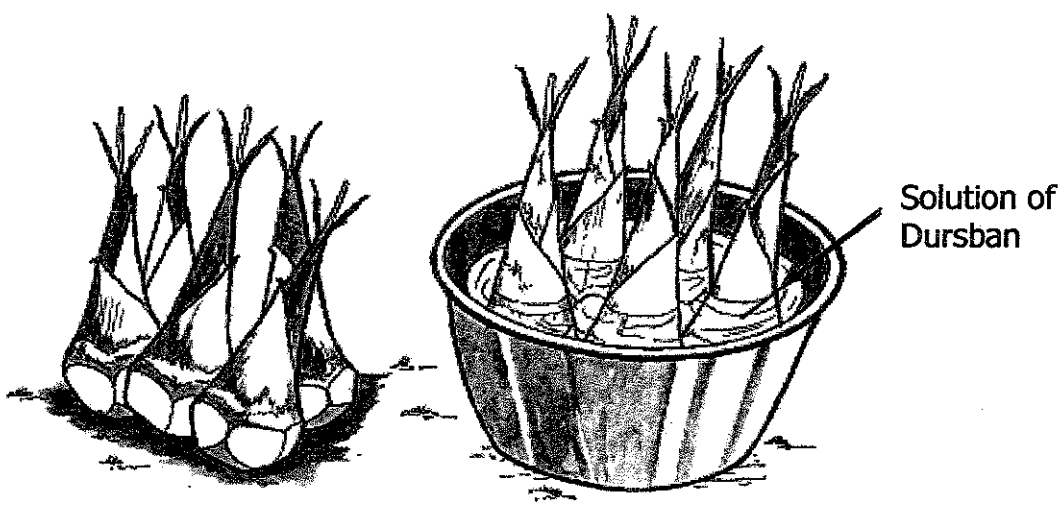
4.1.2 Control of the Banana Weevil

The banana weevil can be controlled by using cultural practices (e.g. clean planting material, proper field sanitation and trapping), chemical insecticides (e.g. dursban, primicid, furadan), biological agents (e.g. fungal pathogens) and resistant cultivars. However, biological control agents and resistant cultivars are not yet fully developed for use.

Use of clean planting material:

Clean (weevil free suckers/corms) planting material should be used when establishing a new plantation. Such material is obtained by selecting suckers from a plantation with low weevil and nematode infestation. The suckers or corms are pared (carefully peeling the corm to expose the inner white tissue) to remove symptoms of weevil and nematode damage. Deeply tunnelled corms should be discarded. The pared material should be removed from the plantation immediately to avoid adult weevils laying eggs in it. To ensure a greater level of cleanliness the pared corms can be subjected to hot water treatment (52 - 55°C for 20 minutes) or chemical dipping (a solution of 1.5 cc of dursban per litre of water for 1 hour) to kill any remaining weevil larvae/eggs (Figure 11).

Figure 11. Suckers peeled and dipped in a chemical solution to kill pests (e.g. weevils)



Note that weevils from neighbouring fields can move into the new field and attack the planted clean materials. Field sanitation and trapping should therefore be regularly done to keep immigrant population in check.

Good husbandry: field sanitation

This involves clean weeding, sucker removal, pruning, manuring and mulching. These lead to production of vigorous plants, which are less affected by weevil damage compared to stressed (poorly managed) plants. In order to reduce hiding and breeding sites for adult weevils, always split or chop up harvested and toppled plant's pseudostems into small pieces that can dry up quickly. Also remove and chop up old corms/stumps to expose weevil larvae and eggs to desiccate.

Trapping

There are two types of traps most widely used, split pseudostem and disc-on-stump traps. The split pseudostem traps are made from 35-45 cm long pseudostem pieces of fresh material cut into 2 equal pieces lengthwise (Figure 12 a). The two halves should be placed with the flat side facing down on the cleared soil surface close to and on opposite sides of a mat. The disc-on-stump traps (Figure 12b) are cut from stumps of recently harvested plants. The stump is cut horizontally 15-25 cm above ground level and a 8-10 cm disc of pseudostem is placed on top. The traps can be modified by placing the banana leaves on top of the stump. The traps should be turned up to remove the trapped weevils three days after laying the traps. Such weevils pretend to be dead when touched. So make sure that you physically kill them.

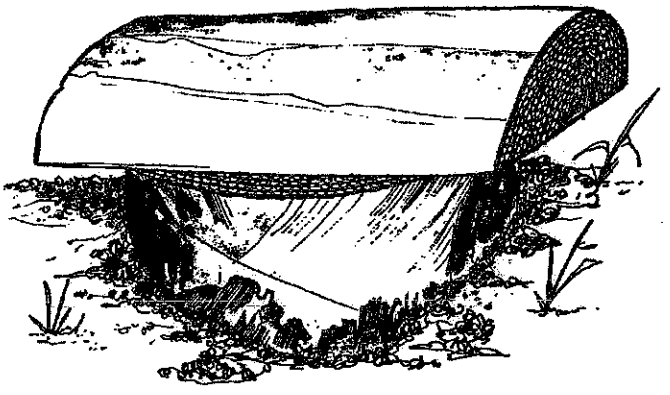
Split pseudostem traps have an advantage over the disc-on-stump trap because the trap material is readily available, are portable and easy to set under a wide range in the field. Disc-on-stump trap normally traps 3-4 times more weevils than the split pseudostem trap but availability of the latter are limited.

An advanced trap type, the pheromone trap, catches more weevils than pseudostem traps. The trap is made up of an attractant chemical (pheromone) hung in a bucket. It can be made as follows: Using a 10-litre bucket, two windows are made (opposite each other) in the bucket. The windows are cut 15cm (0.5 ft) above the base of the bucket. A hole is made at the centre of the bucket cover and a string is passed through the hole to hang inside the bucket. A pheromone packet is suspended in the bucket using the string. The bucket is sunk into the soil in a way that the soil surface is level with the window. A laundry detergent (soapy water) is poured into the bucket to fill the base.

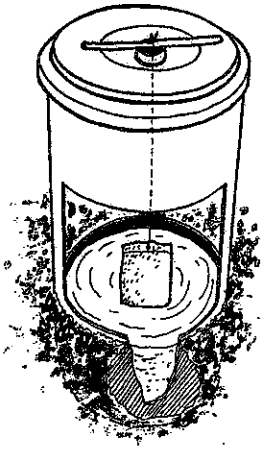
The pheromone lure attracts weevils into the traps and they are prohibited from climbing out by the detergent. Traps should be checked at least once a week to remove the dead weevils and the detergent should be replaced every two weeks. The pheromone in the pack lasts for about a month. The pack should be replaced when the pheromone is no longer seen in the transparent pack (i.e. after one month).

Figure 12. Types of Banana weevil traps.

(a) Split pseudo stems



(b) Disc on stump



(c) Pheromone trap

It is advised to apply a chemical insecticide in the hole and around the sucker at planting to kill weevils that may attack the planted material. The common insecticides in Uganda include Furadan, Primicid and Dursban and should be applied at manufacturers' rates. In the case of an established plantation, insecticides should be applied to the soil around the base of the banana plant mat. A simple shaker in case of granules or a sprayer for the liquid formulations is used. The chemicals can also be applied with pseudostem or disc-on-stump traps in mature banana plantations to kill weevils that get attracted to the traps.

Caution:
Pesticides are very dangerous and their effectiveness is variable. It is extremely important for the farmer to first seek advice from the relevant services (extension workers, researchers and crop chemical agents) who can assess the need by monitoring weevil / nematode damage levels. The expert will then recommend as to whether, when, which and how to apply a chemical pesticide. Using pesticides to clean planting materials is less dangerous because it does not contaminate plants ready for harvest. Note that you (farmer) are strongly advised to apply pesticides only under guidance of an extension worker or an equivalent specialist.

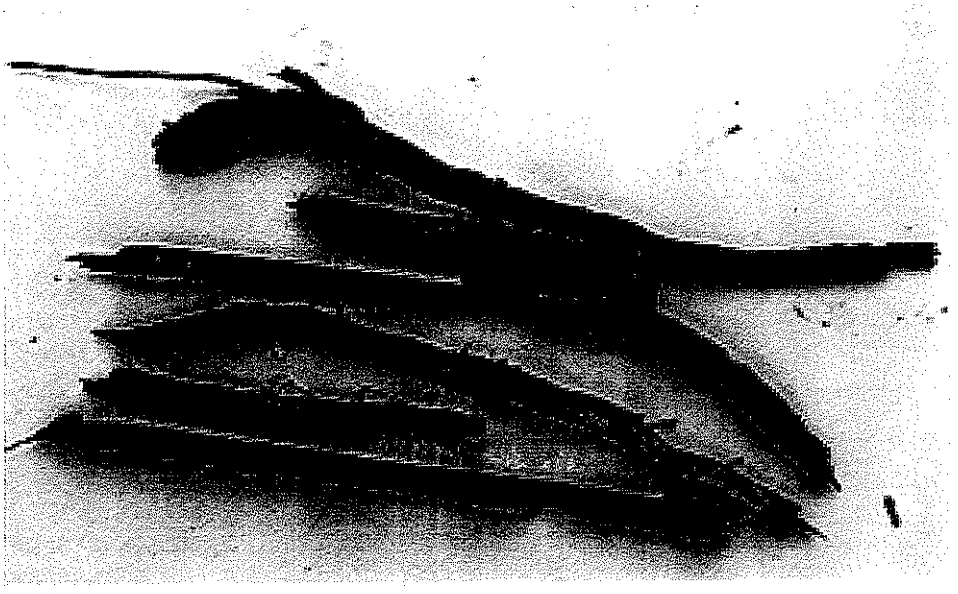
Other (potential) control measures Current research focus is on developing biological control agents and resistant cultivars. Some fungi which kill weevils but do not harm the banana plant are being tested both at laboratory and field levels. On a long term, use of resistant cultivars is the most effective and cheapest method of controlling weevils. Unfortunately, all indigenous bananas (matooke types) appear susceptible. However, most exotic types have a high level of tolerance. These should be used in areas where weevils have reached epidemic proportions. For instance, FHIA 01 appears highly tolerant to weevil damage. It has the potential to replace matooke types where they have failed. Planting materials of this cultivar are available at Kawanda.

4.2 Nematodes

4.2.1 Nematode damage and symptoms

Nematodes are very small worms and cannot be seen with naked eyes. They live and feed inside roots and corm thus destroying them. (They, however, move out into soil when conditions are not favourable in roots.) A root or corm damaged by nematodes shows reddish-purple lesions or patches (necrosis) when split or peeled (Plate 5). Root necrosis results in premature root death or root fracture at points where the necrosis girdles across. The necrosis interferes with the water and nutrient movement into the plant.

Plate 5. Root pieces showing necrosis in the root cortex, a symptom of nematode damage.



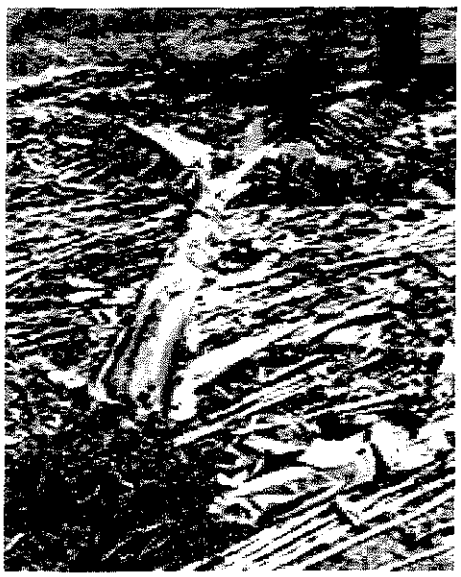
The most obvious symptom of nematode damage is the toppling over of the entire plant, particularly those bearing fruits (Plate 6).

4.2.3 **Management of nematodes**

Use of clean planting material in clean field:

The spread of nematodes across and within regions is attributed to movement of infested planting material from one area to another and can be avoided by using nematode free planting material. Clean planting material can be obtained by corm paring, which could be followed by hot water treatment (at 52-55°C for 20 minutes).

Plate 6. A plant toppled/uprooted due to root damage by nematodes



In general, damage to the banana root system results in stunted plant growth, premature leaf drop, reduced vigour, delayed maturation, slow ratooning, small and poorly filled bunches and increased susceptibility to water deficiency.

In-vitro propagated (tissue culture) plants are also nematode free. They can be accessed through the National Banana Research Programme at Kawanda Agricultural Research Institute (NBRP at KARI). The nematode free suckers should be planted in a nematode free field. This would be a field where bananas or plantain have not been grown before or a field, which has been under a non-host crop for at least two years (Figure 13). Root crops (cassava and sweet potato) and pineapple do not have banana nematodes and hence are good rotation crops for bananas. The non-host crops used in such a situation are generally referred to as break crops.

Use of Chemical nematicides

Use of nematicides is currently the only method that controls nematodes in an established banana plantation. At present the recommended chemical is Furadan (carbofuran) and is available in two formulations, 5G and 10G. For 5G 60 grams are applied per mat while 30 grams are applied when 10G is used. The nematode population should be regularly monitored through regular sampling and assessment of nematode damage in roots. This is done by:

Ants: Black ants (Kaasa), occasionally dig up and soften soil around a banana corm. This renders the plant vulnerable to winds (toppling). The economic importance of these ants is, however, not yet established.

Leaf eaters/miners: Leaf blades and lamina are sometimes attacked by various lepidoptera caterpillars but they are not usually severe enough to require control measures.

5.0 BANANA DISEASES

Bananas and plantains in Uganda are attacked by several pathogens some of which are fungal, others viral, and others bacterial. They cause different diseases including leaf spots and vascular wilts.

5.1 Leaf spots

There are two economically important leaf spot diseases on bananas in Uganda, and both are caused by fungal pathogens. These are black Sigatoka (caused by *Mycosphaerella fijiensis*) and leaf speckle (by *Periconiella sapientumicola)*. Another leaf spot disease called yellow Sigatoka (by *Mycosphaerella musicola)* is common but not important in Uganda. Compared with yellow Sigatoka and leaf speckle, black Sigatoka causes more rapid death of the banana leaves. The latter is therefore the most important as it can kill all leaf tissue, thus reducing the ability of the plant to manufacture the food needed for growth and filling up of the bunch.

Black and yellow Sigatoka produce similar symptoms and are hard to distinguish by a non trained person. However, yellow Sigatoka is characterised by appearance of small yellow streaks (1-2mm long) parallel to the secondary veins of the blade. The yellow streaks grow into brown spots that in turn develop into dark-brown (dead) spots that are more or less round (Plate 7). On the other hand black Sigatoka streaks are brown and gradually enlarge and fuse to form black patches (Plate 8a & b) which later develop spots with grey centres. Meanwhile, the main symptomatic difference between leaf speckle and black/yellow Sigatoka is absence of round spots in leaf speckle diseased leaves (Plate 9).

5.1.1 Factors that favour leaf spot diseases.

Leaf spot diseases, especially black Sigatoka is seen to be more serious in the rainy than dry season. This is because the fungus requires water for producing and spreading the spores that infect other leaves or plants. High humidity in the field also encourages rapid development of the disease. Conditions that encourage high humidity in the field include high plant density, poor field sanitation, high weed growth and poor drainage, in addition to heavy rainfall.

Plate 7. Banana leaf showing symptoms of yellow sigatoka

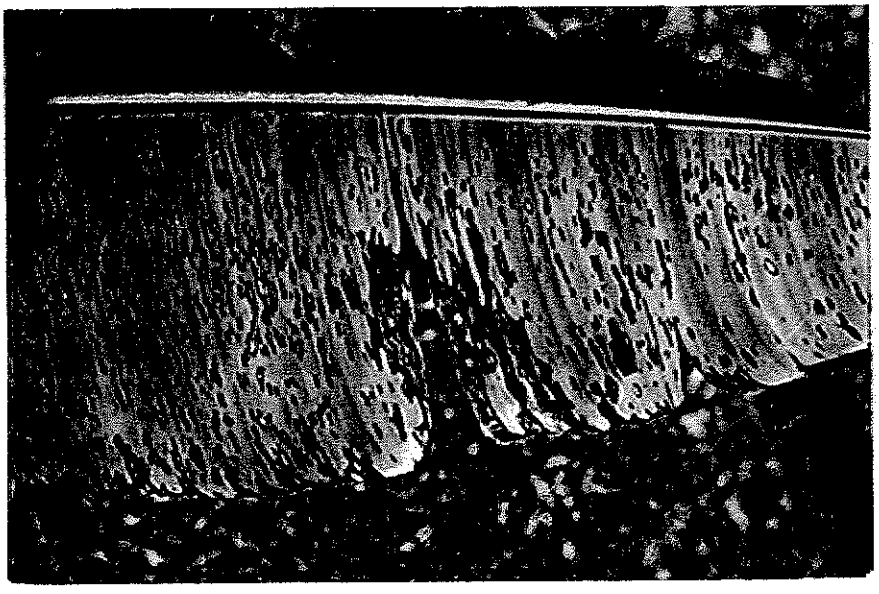


Plate 8. A banana leaf showing symptoms of black sigatoka
(a) Early stages of leaf damage (b) severe leaf damage

(a)

(b)

Plate 9. Banana leaf showing symptoms of leaf speckle disease.

5.1.2 Control of leaf spot diseases (black Sigatoka and leaf speckle)

The cheapest and most effective method of controlling plant diseases is by use of resistant cultivars. At the moment none of the highland bananas (matooke) have been found to be resistant to leaf spots diseases. However, banana hybrids resistant to the disease have been developed and imported into the country (Plate 8). Some of them (e.g. FHIA 01, FHIA 03, FHIA 17 and FHIA 23) have already been proved (by farmers in Luwero and Kibaale) to have fairly good edible (cooking, dessert, Juice) attributes. In susceptible cultivars the level of leaf spot diseases can be reduced and build up of the disease prevented by carrying out practices that reduce humidity in the field. These include maintenance of correct spacing or plant density, good field sanitation, absence of weeds and good drainage. Good fertilisation of the banana plant also reduces the impact of leaf spot diseases through an increase in the rate of leaf production as a result of photosynthesis. Otherwise, the disease itself can only be controlled by using chemical fungicides. These, unfortunately, are not appropriate for most farmers.

5.2 Banana Streak Virus (BSV)

Banana streak virus (BSV) is a recently recognised disease in Uganda. Its importance and means of spread are yet to be fully established. A diseased plant is recognised by the following symptoms:
Leaves initially have yellow streaks (similar to symptoms of Cucumber mosaic) which later turn to golden necrotic streaks (Plate 10). The plant has reduced growth and vigour, may fail to flower or put on smaller bunches which may bear distorted fruits or poorly filled fingers. Some plants develop internal pseudostem necrosis or top die back. Emerging leaves may have no or slight symptoms, which may disappear and re-appear later.

Plate 10(a) Banana plant with leaves showing symptoms of banana streak virus (BSV)

Plate 10 (b) Banana leaf showing symptoms of banana streak virus

5.2.1 Control of BSV

Research is being conducted to establish definite control measures for the disease. Meanwhile farmers are advised to eliminate (uproot and chop) infected plants to restrict the spread of BSV within the field, start new plantations with clean planting materials and provide enhanced nutrition to the plants. Local authorities could impose quarantine measures to stop or reduce spread of the disease into uninfected areas.

5.3 Fusarium wilt disease

Fusarium wilt, also known as Panama wilt (or todura- Nkore), is a soil borne disease caused by *Fusarium oxysporum* f.sp. *Cubense*. It is known to be the most destructive disease of bananas in Uganda as it may lead to losses of up to 100% in a farm of susceptible cultivars. It is known to attack four types of bananas in Uganda: Bogoya (Gros Michel), Sukari-Ndiizi (apple banana), Kisubi and Kayinja. This Fusarium wilt does not infect highland/local bananas, Cavendish cultivars, plantains, FHIA 01, FHIA 17 and FHIA 23.

On the other hand, highland bananas are attacked by another type of wilt called "Matooke wilt". So far it has been encountered only in western and southwestern Uganda at altitudes above 1300 m.a.s.l. Matooke wilt has been found to be limited to areas around homesteads, garbage dumping sites and animal kraals. The causal agent of this wilt syndrome is not yet known, and efforts are being made to establish its means of spread.

5.3.1 Symptoms of Fusarium wilt

Symptoms of the Panama disease include yellowing of leaves, or premature collapse of leaves (Plate 11) Examination of a cross section of a pseudostem and/or corm reveals a characteristic discolouration of the vascular bundles, usually stained purplish-brown (Plate 12 a & b). Sometimes the leaf sheaths loosen and/or the pseudostem splits. A severely infected plant fails to flower, or if it does, the bunch fails to develop and fill up.

Plate 11 A plant (cultivar Pisang Awak – Kayinja) showing fusarium wilt symptoms; yellowing and drooping of leaves.

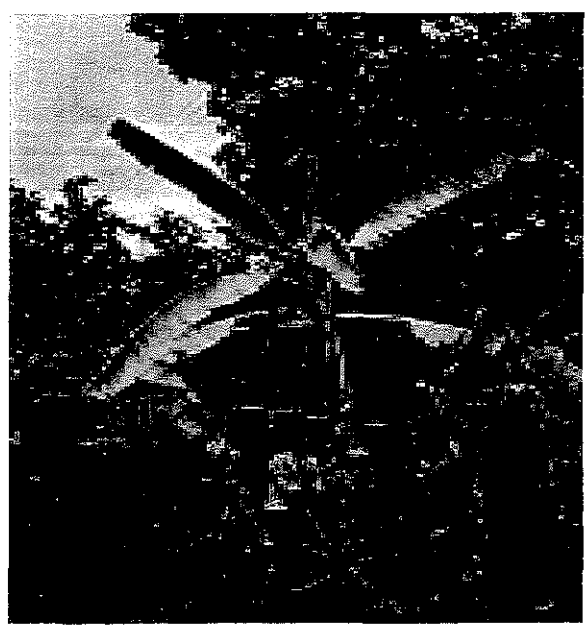
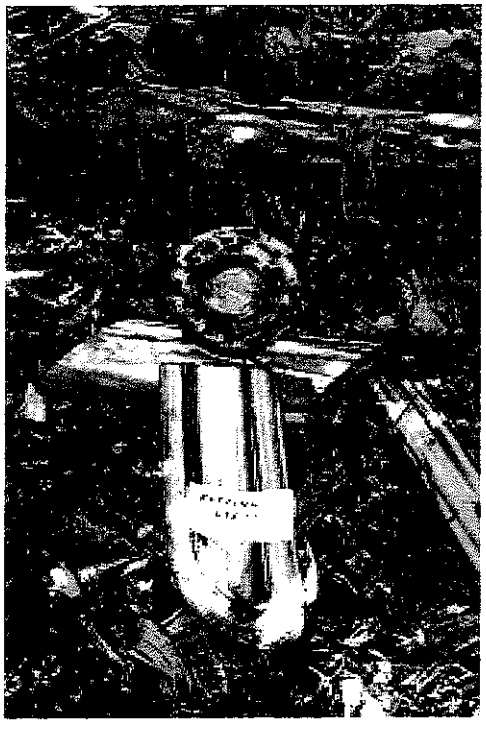
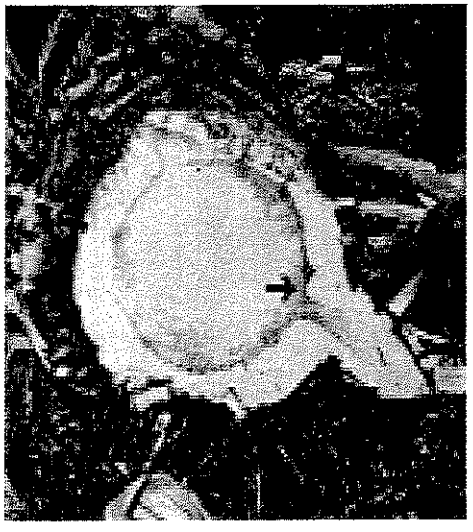


Plate 12. Symptoms of fusarium wilt in a stem



(a)
Discolouration of vascular system of a pseudostem



(a)
Discolouration of vascular tissue in the corn of mother and daughter (developing sucker) plants.

5.3.2 Symptoms of Matooke wilt.

Matooke wilt also causes symptoms similar to those of Panama disease but yellowing and corm/pseudostem discoloration (damage) are less extensive. Leaves of the affected plants do not turn bright yellow as in the case of panama disease.

5.3.3 Control of Fusarium wilt

There are no known therapeutic means of controlling fusarium wilt once the plant is already attacked by the pathogen. Farmers are advised to grow resistant cultivars. These include cultivars like Cavendish, FHIA 17 and FHIA 23 , which may be good replacements for Bogoya; Pisang ceylan which can replace Sukari-Ndiizi; SABA

Yagambi Km5 and Bluggoe which may very well replace Kayinja and Kisubi, with regard to uses. These cultivars are available at KARI and field sites of the Banana Research Programme. Otherwise, use of clean planting materials (preferably tissue culture plantlets) in fusarium-free soils is the only solution if the susceptible cultivars have to be planted.

It has been observed that the severity of matooke wilt disease can be minimised by applying sanitary measures like removing infected plants and applying properly decomposed household refuse to banana fields.

5.4 Minor diseases (Diseases that are not known to cause losses of economic importance)

5.4.1 Corm rot

This disease usually occurs in plantations planted on cleared forestland. It is caused by a fungus *Armillaria* sp. which also survives on some tree species. It persists in stumps and roots of cleared trees, and later invades planted bananas through corms and roots. Aerially, its symptoms resemble those of fusarium wilt (yellowing and death of banana leaves). Examination of the corm however reveals white strands of a fungus. Sometimes toadstool-like threads appear at the base of the plant. The spread of this disease can be reduced by uprooting and burning infected plants, and planting replacement a few metres from the infected site.

5.4.2 Anthracnose

Anthracnose is a disease caused by a fungus *Colletotrichum musae* and attacks the fruit. It is most common on cooking bananas. Its symptoms include initially, small black circular specks on the flowers and skin, and distal ends of banana hands. The damage increases in size and later become sunken and coalesces, forming large spots on the surface. As the fruit matures, typical spots develop. In severe cases the fruit is entirely covered with dark blemishes. It is however observed that only the cosmetic value is lost. The quality of pulp is not affected by the disease. However, for export fruits, it is a major disease because affected fruits are rejected. Export fruits require treatment with fungicides recommendations of which vary with distributors in the consumer country.

5.4.3 Cigar end disease

This is a disease that gives banana fruits an appearance of a lit cigarette with an ashy tip. It is air-borne and caused by fungi, *Verticillium theobromae* and *Trachysphaera fructigena.* Pulps of infected fruits get rotten (either dry or wet rotting). Cigar end rot disease tends to be favoured by high humidity. So far it is known in some parts of Kabarole, Kabale and Rukungiri. Old and badly maintained plantations suffer most damage. The disease incidence can be reduced by removal of flower remains from fruit.

6.0 HARVESTING AND POST HARVEST HANDLING

The time taken from flowering to harvest varies with cultivars, climatic conditions and sometimes management practices. Generally bunches take 3 to 5 months to mature. Hybrids and exotic bananas have been found to take slightly longer than local cultivars.

Most bananas are grown for food or sold to local traders who transport them to rural or city markets. These traders collect whole bunches from the field and load them on to vehicles with no special attention paid to post-harvest care. Bruising and damaged skin does not really affect the cooking quality of matoke banana and consumers are not ready to pay higher prices for banana just because it looks better.

Slightly more care is taken with Bogoya and Ndiizi types of sweet banana since these are eaten ripe have softer skin and cannot be eaten if they are badly bruised. In general there is a high level of wastage in these bananas but, they are cheap food and consumers are not usually prepared to pay higher prices for better quality fruit. This may change in the future.

As well as the wastage of fruit, the major problem in transporting whole bunches from field to market is the loss of organic matter. If fruit is cut from the stems in the field, the stems remain and provide valuable mulch to enrich the soil. New systems of transporting hands of fruit rather than whole bunches would benefit both consumers and growers.

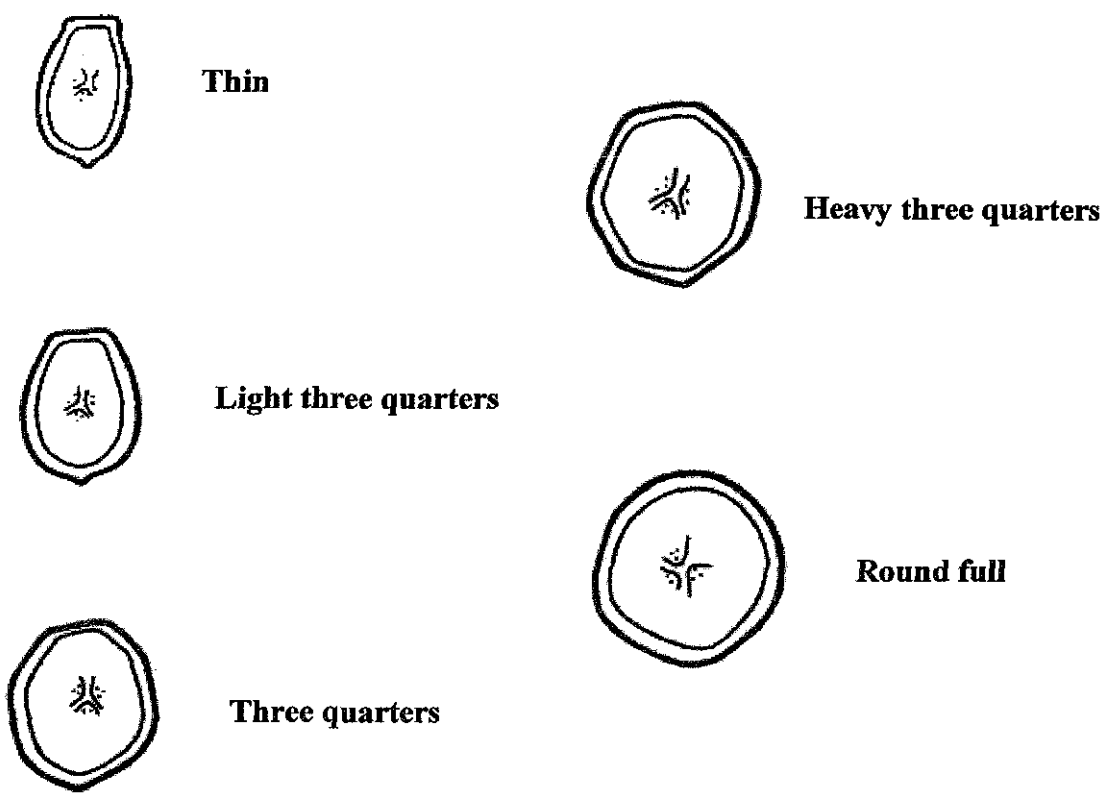
For export bananas, fruit hands must be cut from the stem, selected for appearance and size, and carefully packed in the field or in a special packhouse close to the field. The post-harvest methods described below apply mainly to export fruit although there would also be some benefits if bananas for the local market were also handled more carefully.

6.1 When to harvest

In order to develop their full characteristic flavour, taste and colour during storage (or when intentionally ripened) fruits need to be picked at optimum maturity. Fruits harvested young are more susceptible to shrivelling, mechanical damage and have poor eating quality when cooked or upon ripening (in the case of dessert bananas). On the other hand, harvesting at an advanced stage of maturity is not good for fruits intended for export marketing since they may need to spend more than a week within the marketing system before reaching the consumer. It is important to identify key indicators of maturity for the bananas in order to be able to harvest them at the right stage and time. These maturity indices should ensure acceptable eating quality and long shelf life especially for sweet bananas.

The most significant visual changes occur in the size, shape, length and volume of the fruit as bunches advance in age. During early stages of development, individual fingers are angular, however as growth progresses, fingers become more rounded and full in shape. The maturity of a banana can be measured by the types of ridges on the peel, as shown in figure 14. This is referred to as the grade of the fruit. In major exporting countries the grades are described as: thin, light three quarters, three quarters, heavy three quarters and round full.

Figure 14. Cross section of banana fruit showing ridges used to determine fruit maturity grade



As a general rule fruits should not be harvested in the thin grade because the bunch sells for a lower price and the fruit shrivels quickly. Fruit should normally be harvested at about three-quarters grade to withstand transportation and storage of 4-6 days before they start to ripen, although this depends on the type of banana. Round full and heavy three quarters Bogoya and Ndiizi types will ripen quickly but have the best flavour for

home consumption or short-term marketing. Sweet banana fruits of these types also change from dark to a lighter green colour, as they advance in maturity (Plate 13). At the light green (colour ranges 2 – 3) stage the fruits are mature enough to ripen easily.

6.2 How to harvest

The harvesting system depends upon the type of banana and the market. In every case though, a cut should be made with a panga in the pseudostem (trunk) which allows the bunch to descend slowly under its own weight or with the help of a tug on the lower end of the bunch stalk. For local market fruit the upper end of the stalk above the fruit should be sliced through whilst holding the lower end up (Figure 15). The bunch will then fall through 180 degrees and land balanced on the thick end of the stalk, with no damage to fruit. Some bunches may be too heavy or too high for this system to work, but every effort should still be made to prevent the bunch falling heavily on to the ground. Fruit that is bruised during harvesting, has a shorter post-harvest life, ripens quickly and may not have good eating quality.

For export bananas of all types, the bunch should not be allowed to fall to the ground. The bunch should be held at around head height and each hand of fruit cut from the stalk with a sharp knife, allowing the latex to fall on to the ground below and not on to other fruit. The hands are then placed on a freshly cut banana leaf laid on the ground (Figure 16) until the latex stops running and dries up. They are then ready for selection and packing into boxes.

Plate 13 Colour changes as a fruit advances in maturity

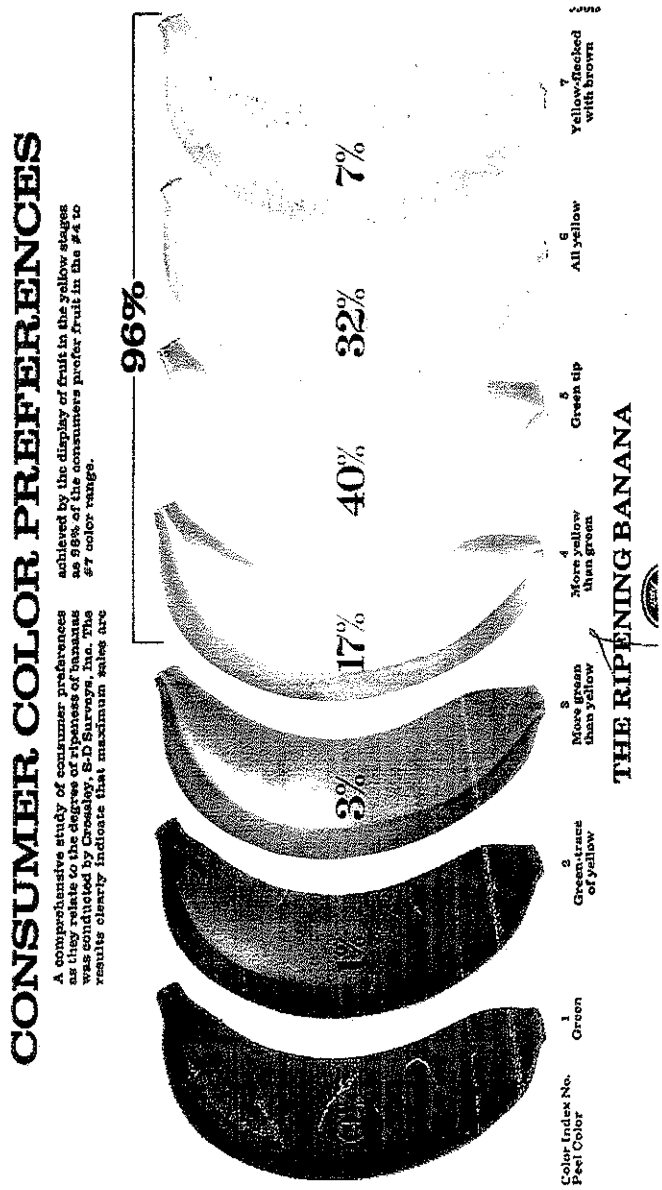


Figure 15 Lowering a bunch

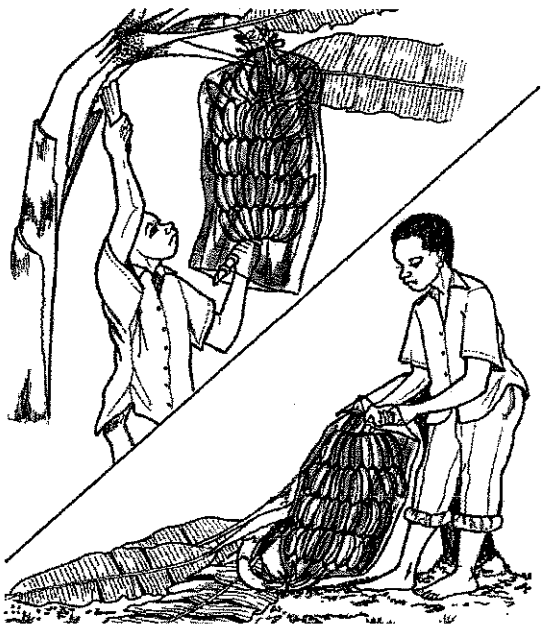


Figure 15. Harvesting should be carried out without the bunch bouncing on the ground

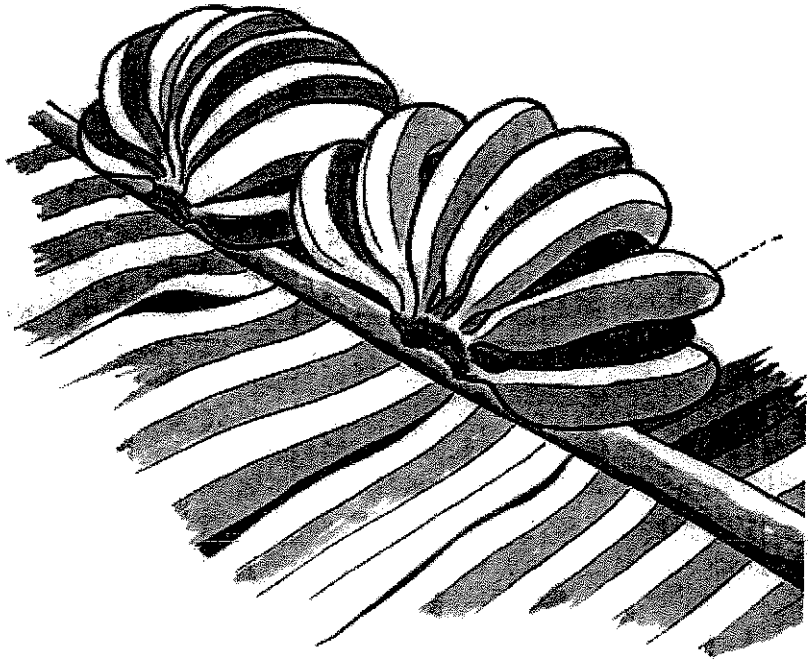


Figure 16. Dehanding and drying of latex for export fruit

6.3 Packaging and transport

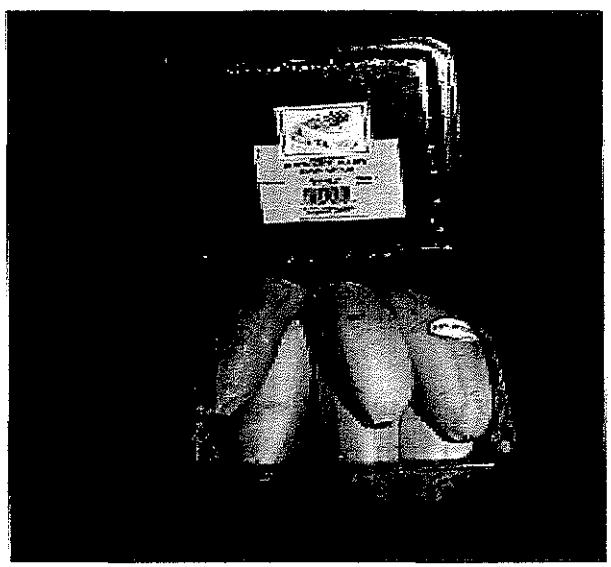
The trader usually packs export fruit into

cardboard boxes in the field. Matoke types are packed 9-10 kgs per box and Ndiizi 6 kgs. Bogoya is not usually exported. The fruit must be handled and packed carefully to avoid scratching and bruising. It must be washed in clean water and packed tightly into boxes to prevent movement and peel rubbing during transportation. Growers tend to pack too much fruit into boxes so that the fruit is bruised when one box is stacked on top of another. This is a major cause of damage and price reduction in export fruit.

Matooke bananas are exported to Europe by air and sold mainly to Ugandans and other ethnic communities living in Europe. There is also a big demand for well-packaged apple banana (Ndiizi) for major European supermarkets. However the level of quality control and packaging, as shown below, cannot be achieved at present in Uganda. This type of quality requires a modern packhouse with specialised handling equipment, linked to plantation as well as smallholder production

Plate 14. A retail pack of apple banana

Plate 1 Prepack of Columbian apple bananas purchased from Waitrose supermarket February 1997
(pack internal dimensions of box = 150 x 150 x 70mm)



Uganda apple banana

Some bananas are also exported to neighbouring countries by road. Price is normally the main issue for these bananas, and no specialised post-harvest techniques or packaging are employed.

6.4 Storage

Bananas often have to be stored for a few hours or days, and at different points in the marketing chain, before they are finally sold. The most important point to remember during storage is that the fruit should be kept as cool as possible.

In major exporting countries, refrigeration is often used during storage and transport, to ensure a long shelf life and good quality. In Uganda this is not available so bananas must be stored in a well-ventilated place, out of the sun. The common practice of leaving the fruits exposed to direct sunlight and in heaps should be avoided.

Bananas must not be stored where there is smoke or exhaust gases from trucks since these cause ripening to take place quickly.

6.5 Alternative uses of bananas

Bananas in Uganda are currently largely used in their fresh form (i.e. either wrapped in leaves and steamed, boiled or roasted). Dessert bananas (Bogoya and Ndizi) are usually eaten ripe and used for making pancakes (Kabalagala). The most common form of processing is beverage production from beer/juice banana cultivars (juices, beer, waragi).

Apart from these common uses, bananas can be processed into other products such as figs and flakes by drying ripe bananas. Green bananas can be fried to make crisps. They can also be dried into chips, which can later be reduced into flour. The flour can then be used to make many different bakery and fried products, or could be used as ugali. Juice processing can also be improved by employing enzymatic extraction and preservation of the final product.

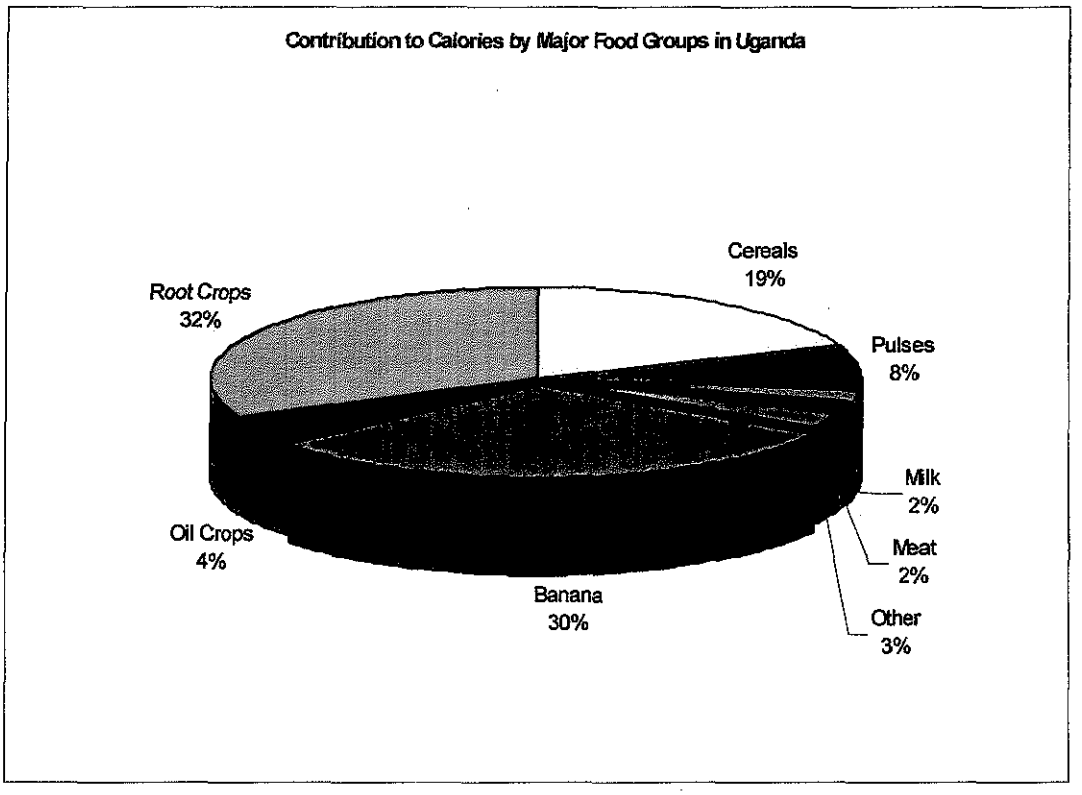
Although there is good potential for new processed products, the market is under-developed in Uganda, and processing can only be carried out economically for home consumption or if the grower has a definite buyer for the finished product.

7.0 ECONOMICS OF BANANA PRODUCTION IN UGANDA

Bananas make a major contribution to the economy of Uganda. Production is mainly by small-scale farmers with two main objectives: (1) food and (2) cash income. Bananas are an essential component of household food security in many Districts because they are harvested throughout the year with peak production during the dry season.

The crop provides a steady supply of food throughout the year, both to the urban and rural population and is a major source of income in most of the rural areas of the country. It is estimated that bananas provide 30% of the calories (Figure 17), 10% of protein and 5% of fats for the entire population of Uganda.

Figure 17. Contribution of bananas to diet



A study to analyse the costs and benefits of banana production was carried out in Kisekka sub-county in Masaka district during 1998. The major input costs reported by farmers were for labour, fertiliser and mulch. Chemicals were not used. Table 4 shows amount of labour allocated to different activities.

Table 4. Labour allocated to different activities in banana production per hectare/year (Kisekka sub county, Masaka)

Activity	Person-days Per ha	Cost (Ug Sh) per ha
Sheath removal	10	41,900
Split pseudo stems	5	11,300
Chop stumps	6	32,700
Remove old corms	11	61,600
Cover mats with soil	6	36,900
Weeding	46	148,800
De-leafing	8	33,800
De-suckering	8	61,750
Mulch application	4	17,600
Manure application	9	32,950
Total	**113**	**479,300**

Since farmers do not keep written records, often allocate work on a task basis and do not closely supervise labour, the average labour cost per day appears to be high at 4,242/= per day.

Fertilizers used in banana production are mainly obtained locally and include animal manure, urine, kitchen refuse and crop residues. Growers estimated the cost of animal manure to put in one hectare of bananas at Ug Sh. 889,000/=. However, most farmers applied manure only once in three years. Spreading this cost over the three years leaves a cost for manure of Ug. Sh. 296,400/= per ha per year.

Many banana farmers use mulches to improve the moisture status of the soil and suppress weeds. Mulches can be obtained cheaply by using crop residues, mainly maize, beans and banana residues. In the absence of sufficient crop residues, growers buy swamp grass, elephant grass and other grasses. The cost of grass mulch to cover

one hectare of bananas was estimated at Ug Sh 712,200/= for Kisekka sub-county. Most farmers applied mulch once in three years. Spreading the above cost over the three years gives a cost of mulch of Ug Sh 237,400/= per ha per year.

The total cost of labour, fertilizer and mulch was therefore estimated at Ug Sh 1,013,100 /ha /year as shown in table 5.

Table 5. Costs of producing one hectare of bananas per year.

Input	Cost (Ug Sh) ./ha/year)
Labour	479,300
Animal manure	296,400
Mulch	237,400
Total costs	1,013,100

The income earned from one hectare depends on the yield obtained, and the selling price of the bananas. Growers in Kisseka reported an average yield of 27.4 tones/ha/year, based upon the number of bunches harvested and the average weight of a bunch. The average price obtained was Ush 1,250/- per bunch or 50,000/= per tonne. Based upon these figures a farmer using paid labour would earn a gross margin of Ug Sh 356,900 /ha/year from matoke bananas, as shown in table 6, Ush 836,200 if home labour is used.

Table 6. Gross Margin from producing one hectare of bananas in Kisekka subcounty, Masaka

Item	Under hired labour	Under family labour
Gross revenue from 27.4 tones at 50,000/= each	1,370,000/=	1,370,000/=
Total costs (expenditure)	1,013,000/=	533,800/=
Gross margin (family income) per hectare per year	356,900/=	836,200/=

8. MARKETING BANANAS

Bananas are grown for food, and to sell for cash. Growers usually sell their bananas in the field to traders, for re-sale in local or city markets. However, a small proportion of bananas is bought for export by road to neighbouring countries or for air-freighting to Europe and other overseas markets.

The quantity of bananas crossing the border into Kenya, Rwanda and Congo, estimated from a survey at selected border points, is shown in table 7. The total weight of bananas exported was estimated at 3,821 tonnes, with an approximate value of Ug Sh 600 million (US$ 400,000). This can be expected to increase in future years as the demand for food increases.

Table 7. Estimates of cross-border trade between Uganda and neighbouring countries for 1999

	Lwakhakha	Malaba	Busia	Katuna	Mutukula	Total
Matooke	480	240	96	2,400	-480	2,736
Ndiizi	96	48	48	5	0	197
Bogoya	240	576	72	0	0	888
Total	816	864	216	2,405	-480	3,821

Source: ADC/IDEA project

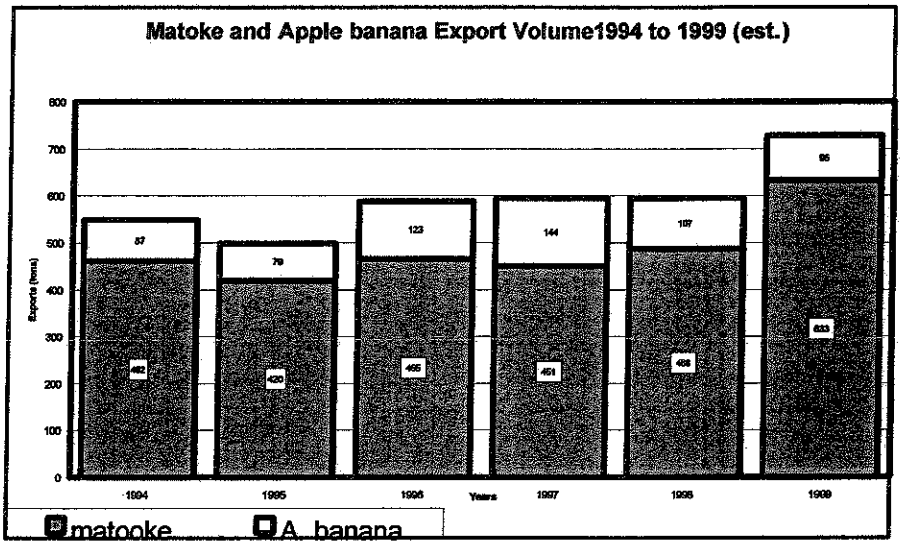
Matoke and apple bananas are also exported to Europe. Figure 18 shows that export quantities have gradually increased from 545 tonnes in 1994 to an estimated 724 tonnes in 1999. The combined value FOB of matoke and apple banana exports to Europe in 1999 was approximately Ug Sh 1.19 million (US$ 796,000).

The potential for growth in matoke exports to Europe is low since it is largely consumed by Ugandans living in Europe. Buyers do not expect it to become popular with European consumers. Investment in matoke for export is therefore not recommended.

There is potential for expanding the market for apple banana but major improvements are needed in production systems to produce fruit which meets EU standards for quality and shelf life. Ndiizi is currently produced almost entirely by smallholders and has too many bruises and skin blemishes for the European supermarkets. Research is also needed in packaging and handling systems, which will ensure a long shelf life. Expansion will also depend on investment in packing facilities and refrigeration,

which meet EU food safety requirements. This means that smallholders will only be able to benefit from apple banana exports as future outgrowers for well-financed plantations with modern packing facilities.

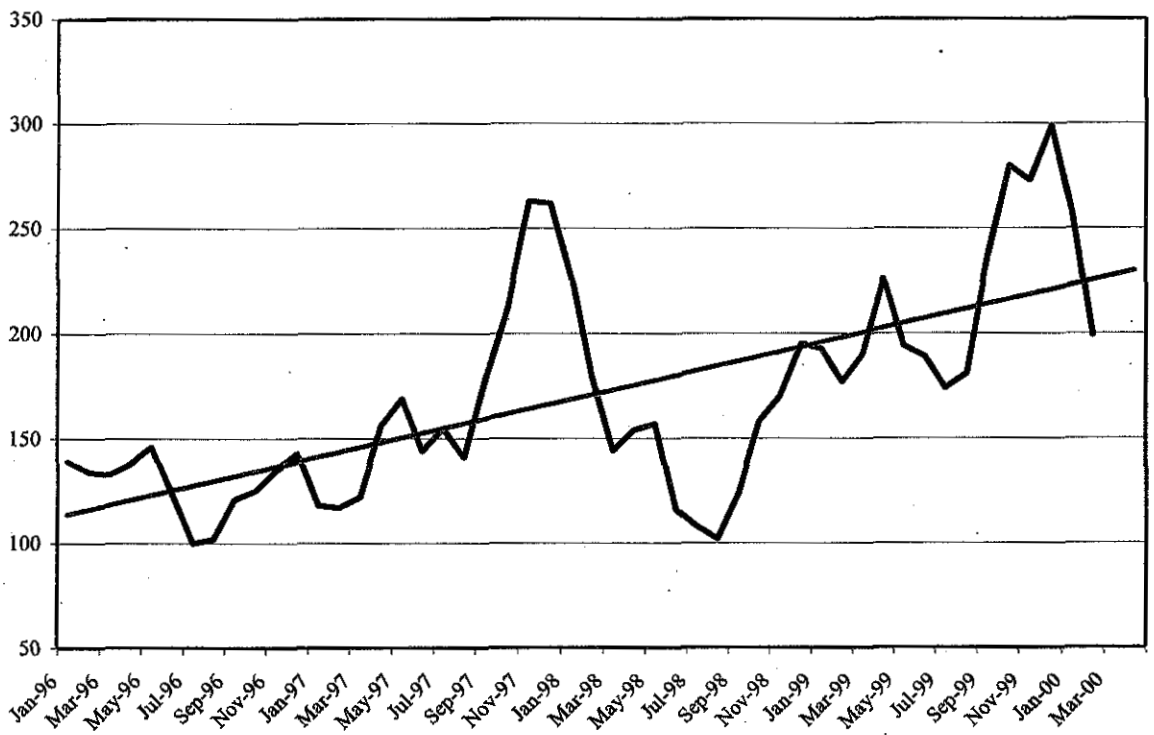
Figure 18. Banana exports to Europe



Source: ADC/IDEA project

Future projects for banana growers also look good since demand and prices on the Kampala and other urban markets are continuously increasing. Data collected by the BOU in Kampala show that the prices of matooke has increased by more than 25% per annum during the period 1996-99 (Figure 19).

Figure 19: Price Trend for Matooke in Kampala Center, 1996-2000 (Feb)



Bank of Uganda, Research Dept.

9. FURTHER INFORMATION

Technical staff are always available at the National Banana Research Program Kawanda. NBRP and the IDEA project have also established demonstration plots in various districts where training is carried. Your local extension officer should have information on this. The following books and publications are also available from NBRP or local bookstores.

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9.2 ABOUT NARO

The National Agricultural Research Organisation (NARO) is a semi-autonomous organisation established in 1992 by a statute enacted by Uganda Parliament. This act brought under one umbrella agricultural research, which hitherto had been conducted in units under seven different ministries. The mandate of the Organisation is to undertake, promote and streamline research in fisheries, forestry, agriculture and livestock and to ensure the dissemination and application of research results. The objective is to contribute towards improving the welfare of the people of Uganda by increasing productivity and utilisation of crops, livestock, fisheries and forestry resources in a sustainable manner. The Vision is to be a centre of excellence spearheading generation and transfer of improved and appropriate technologies in collaboration with its partners and clients, leading to sustainable agricultural development. The mission is to improve the welfare of the people of Uganda through generating improved technology recommendations, transferring them to clients and beneficiaries, and maintaining an agricultural research institution that is relevant for National development and capable of producing the outputs in an efficient, effective and sustainable manner. The main target beneficiaries of NARO are small-scale producers in the agricultural sector.

Activities of NARO

These include: formulating national research plans and priorities; conduction on-station and on-farm research; cordinating and monitoring implementation of national research programmes; developing human resources to increase research efficiency; establishing and promoting internal and external linkages; establishing improved human resource management systems; cordinating donor support to agricultural research; reviewing and evaluating research performance; and ensuring dissemination and application of research results. Important to note is that stakeholders are involved in all activities right from the start to end.

In the recent restructuring process in the Ministry of Agriculture Animal Industry and Fisheries (MAAIF), extension was decentralised to districts and NARO was placed at the centre. District Farm Institutes, now called Agricultural Development Centres (ADCs), were also given to NARO for adaptive research.

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For more information, please contact:
The Director General, NARO
P.O. BOX 295, Entebbe, Uganda
Tel. 256-41-321348/320512/320472
Fax:256-41-321070
E-mail: narohq@imul.com or mukiibi@imul.com