# Tropical banana information kit

Reprint – information current in 1998

## REPRINT INFORMATION – PLEASE READ!

**For updated information please call 13 25 23 or visit the website www.deedi.qld.gov.au**

This publication has been reprinted as a digital book without any changes to the content published in 1998. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research:

- Chemical recommendations—check with an agronomist or Infopest www.infopest.qld.gov.au
- Financial information—costs and returns listed in this publication are out of date. Please contact an adviser or industry body to assist with identifying more current figures.
- Varieties—new varieties are likely to be available and some older varieties may no longer be recommended. Check with an agronomist, call the Business Information Centre on 13 25 23, visit our website www.deedi.qld.gov.au or contact the industry body.
- Contacts—many of the contact details may have changed and there could be several new contacts available. The industry organisation may be able to assist you to find the information or services you require.
- Organisation names—most government agencies referred to in this publication have had name changes. Contact the Business Information Centre on 13 25 23 or the industry organisation to find out the current name and contact details for these agencies.
- Additional information—many other sources of information are now available for each crop. Contact an agronomist, Business Information Centre on 13 25 23 or the industry organisation for other suggested reading.

Even with these limitations we believe this information kit provides important and valuable information for intending and existing growers.

**This publication was last revised in 1998. The information is not current and the accuracy of the information cannot be guaranteed by the State of Queensland.**

This information has been made available to assist users to identify issues involved in the production of tropical banana. This information is not to be used or relied upon by users for any purpose which may expose the user or any other person to loss or damage. Users should conduct their own inquiries and rely on their own independent professional advice.

While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained in this publication.

Queensland Government

# *Growing* THE CROP

*This section is our recipe for growing and marketing a commercial crop of bananas in the wet tropics. To keep the section as brief as possible and easy to follow, we provide little explanation with the recommendations. Where more information may help, we refer you to other sections of the kit. Symbols on the left of the page will help you make these links.*

# The banana plant

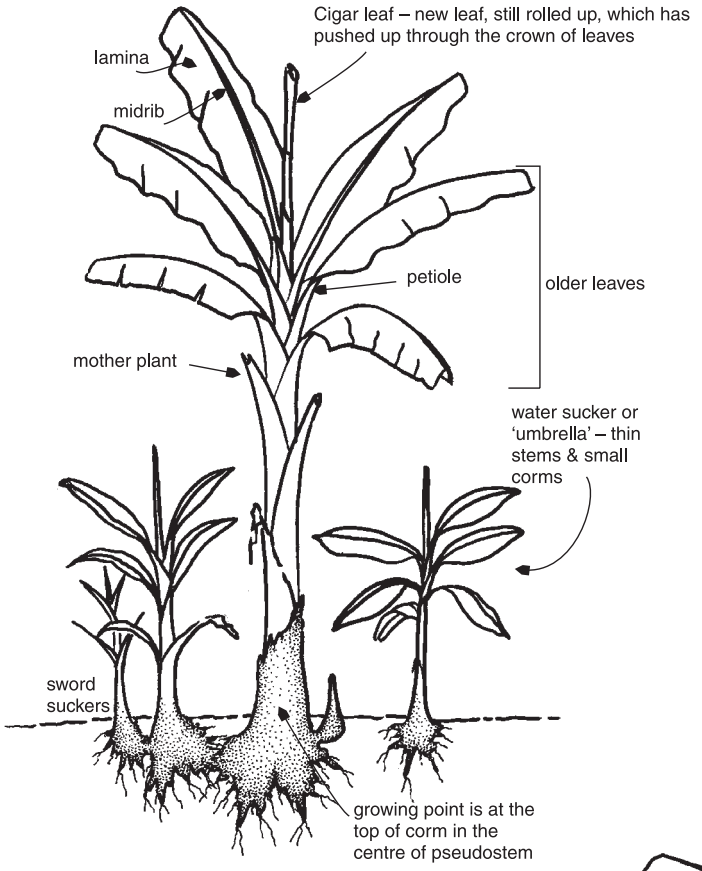



***Figure 1.*** *Banana stool – vegetative stage*

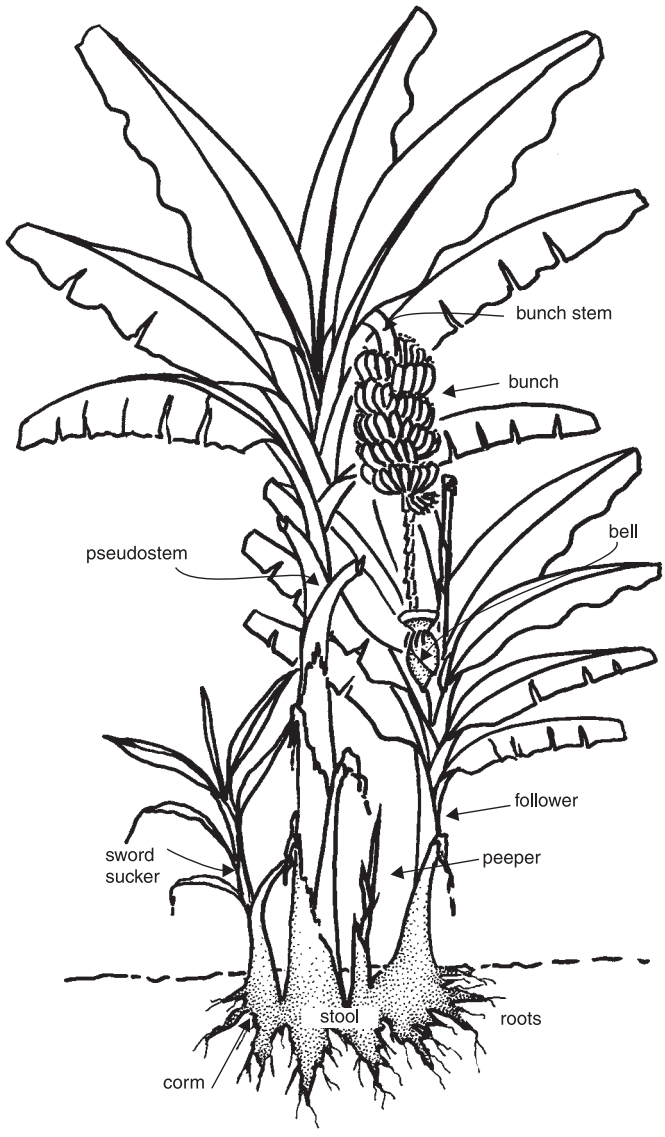



***Figure 2.*** *Banana stool – reproductive stage*

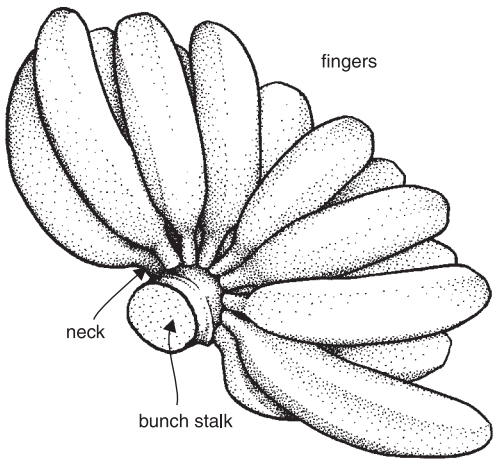



***Figure 3.*** *Hand of bananas*

# Getting the crop started

*Setting up a banana plantation that will be profitable in the long term requires careful planning and attention to details. You need to start planning your plantation and thinking about your marketing options well before the crop is planted. There are legislative requirements that must be addressed and you should prepare a business plan that takes into account the variable returns and significant risks associated with banana production.*

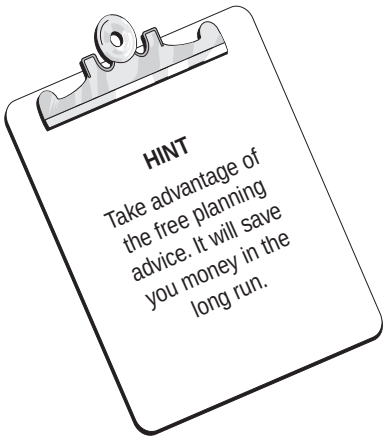


## Plan plantation layout

A well planned plantation layout incorporates:

- safe all-weather access
- row direction to suit runoff control and drainage
- irrigation design
- plant spacings
- specialised erosion control and/or drainage structures
- windbreaks.

The preparation of a farm plan using a photographic base map can be useful. This enables the plan for row direction, access, irrigation mains and drainage to be shown on the farm map as overlays that can be changed easily until the best farm layout is obtained.




Soil conservation officers with the Department of Natural Resources provide free advice and can help you prepare the farm plan.

## On-farm access

Safe all-weather access on the farm is essential. There are three key areas.

**Heavy vehicle access from main road to shed.** These roads should be capable of carrying trucks transporting fertilisers, chemicals, cartons, and bananas to and from the farm in all weather.

**Main plantation (hauling) roads.** These roads are best located in dry areas such as ridge lines and on the contour. They are used for moving trailer loads of bunches from the plantation to the shed. They also carry fertiliser spreading and crop protection equipment. These roads should have well formed crowns and adequate side drains and be accessible in all weather.

**Field roads.** These roads provide access within the plantation blocks for picking, fertilising and spraying and require some soil forming to provide adequate drainage and runoff control.

There are four important points to remember when planning the plantation layout:

- always consider the drainage, runoff control and irrigation requirements when designing access to the plantation;
- locate access roads on ridge lines or on the contour wherever possible;
- divert water from blocks away from access roads wherever possible;
- maintain roads in good condition. (Good roads mean less bruised fruit.)

## Control erosion

Soil erosion can be a significant problem in banana plantations in north Queensland, especially on steep slopes and in undulating areas. High intensity rainfall produces large amounts of runoff that will remove topsoil and nutrients unless effective runoff control measures are in place. These control measures aim to slow the runoff enough to prevent soil erosion while still providing adequate drainage.

Land with slopes greater than 15% is generally considered too steep for tropical banana production because of the difficulty in constructing, maintaining and working soil conservation layouts. To be most effective, erosion control must include runoff control and the maintenance of ground cover.

There are four main parts to a soil conservation system in bananas:

- diversion banks
- contour mounds
- grassed waterways
- access roads.

### *Diversion banks*

Diversion banks prevent runoff water entering from outside the banana block. They are often built directly above the plantation to divert excess runoff into a stable watercourse or grassed waterway. Diversion banks need to be established before the plantation is developed.

### *Contour mounds*

Contour mounds are constructed to carry the water slowly across the slope to decrease erosion.

**Layout**
Contour layouts are kept parallel by varying the gradients of the mounds between a set minimum and maximum. Occasionally, on uneven country, the row gradients may become too flat or too steep and then a correction bay containing some short rows is needed.

To achieve the best soil conservation layout some land preparation may be necessary before marking it out. Any hills and hollows such as old wash lines that will not be used for waterways should be filled and levelled. This allows for more even curves in the mounds and there is less likelihood of the rows or banks overtopping.

**Construction**
Use a grader, v-blade or ditcher to build contour mounds to a height of 30 cm (Figure 4). The minimum height after settlement should be 20 cm. The mounds can be made wide enough for double rows of bananas on land with a slope of less than 6%. On steeper land it is best to plant a single row of bananas on each mound because it is difficult to build big enough structures. Mounds on steeper land tend to look like terraces unless the row spacings are very wide. Terrace-like mounds cause problems in reaching bunches when picking and in destroying the old stool when ploughing out.

### *Grassed waterways*

Grassed waterways are constructed on natural, grassed depressions which receive runoff water from the other structures. Water runs down the waterway to the watercourse.

**Construction**
Waterways are best constructed with a scraper or scoop. It is important that the rows are able to drain freely into the waterway.

**Stabilisation**
Grassing waterways can be difficult. Lack of rain can prevent seed germination or too much rain can cause wash-outs of recent grass plantings. It may be necessary to irrigate until the grass is established. Creeping grasses such as broadleaf carpet grass (*Axonopus compressus*) or Signal grass (*Brachiaria decumbens*) are most suitable. A quick growing annual such as Japanese millet may be used to give temporary cover until the grass establishes.

Hydromulching, where a mixture of seed, fertiliser and stabiliser is sprayed on the surface of the waterway, can be very effective though the cost is relatively high. Hydromulching would probably only be used when other methods have not worked.

**Maintenance**

Inspect waterways and contour mounds regularly and repair damage promptly. Machinery or animal damage to mounds should be repaired so that the mounds are at least 30 cm high (settled height 20 cm). Grass in waterways should be kept short to ensure adequate runoff flow. Major repairs to waterways should generally be left until after the wet season to allow time for grass to regrow.

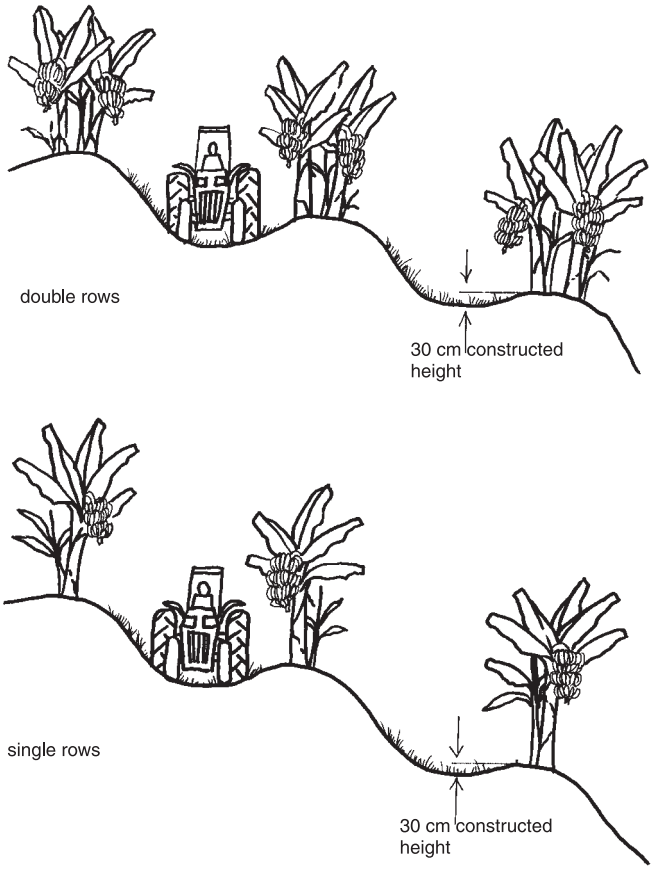



***Figure 4.*** *Transectional view of contour mounds*

## Control runosff in the interrow area with ground covers

Ground covers provide protection from erosion by lessening the impact of rainfall droplets and slowing the movement of runoff water. After planting, do not cultivate or spray grass and other weeds in the interrow area. The weeds reduce soil erosion and only occasional slashing is necessary. Focus your attention on weed control in the planted row.

When the crop canopy is fully developed, shading will further restrict weed growth. If trash from harvesting and deleafing operations is

placed in the interrows, ensure pseudostem material is chopped up so that it breaks down quickly and does not impede runoff.

Various plant species including Pinto's peanut (*Arachis pintoi*) are being evaluated as ground covers in bananas. Always keep ground covers away from the base of plants as they can interfere with insecticide and nematicide applications aimed at the plant corm and surrounding soil.

### Access roads

Access roads should be located in drier parts of the plantation, such as ridge lines and on the contour (Figure 5).

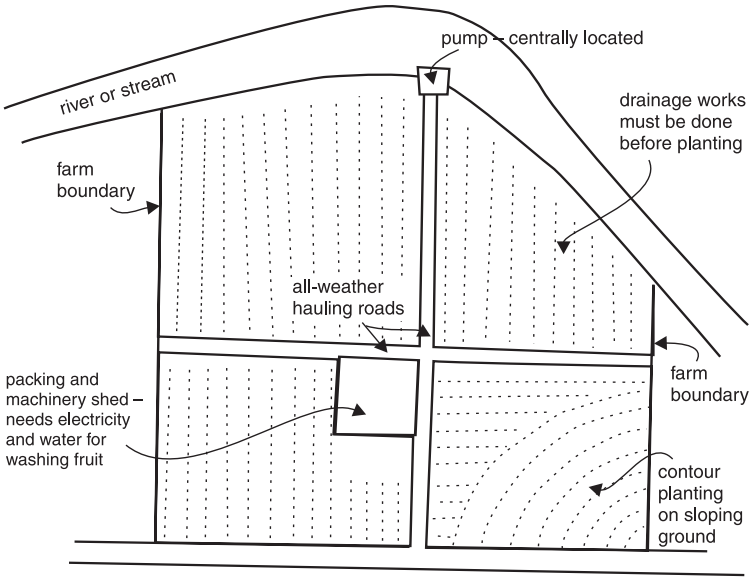



***Figure 5.*** *An example of a plantation layout showing access roads, contours and orientation of rows*

## Drainage

Yield will be reduced and fruit quality will be poor if surface and internal soil drainage are not adequate. Watertables should be maintained below 1 m for optimum growth.

Poor drainage can also result in problems with plantation access. This can adversely affect management of pests and diseases, and their incidence, as well as creating problems for harvesting and transporting fruit to the packing shed.

Humidity can also increase the incidence of leaf spot infection. Leaf spot control is improved if all surface water is removed from the paddock. It is advisable not to plant near permanent water such as swamps and springs.

An examination of colours in the subsoil can provide some indication of drainage status. Orange and black mottling of the subsoil indicates periodic water saturation while blue or grey subsoil indicates continuous saturation.

In sites where drainage is likely to be a problem, the following management practices can be used:

- use diversion drains; (They prevent runoff from entering the paddock.)
- align rows in direction of maximum fall; (This will be up to about 2% gradient for most soil types.)
- use mounded rows; (They will help dry out the major root zone more quickly and help keep this area above the watertable.)
- provide good outlets. (Drains must be lower than the interrows to ensure the interrows drain completely, thus avoiding poor plant growth and interrow bog holes at the ends of rows.)

### Benefits of a good plantation layout

A good banana plantation layout means:

- higher yields from reduced losses of soil and plant nutrients;
- less maintenance of roadways and interrow passageways;
- fewer restrictions to essential operations (pest and disease management, bagging and harvesting) after heavy rain because of better access;
- minimised postharvest bruising in transit to the packing shed because of better access roads;
- more efficient irrigation due to more even distribution of water pressure along contoured banana rows;
- more efficient use of available water, particularly during drier periods;
- improved drainage in wet areas;
- reduced chemical and sediment pollution of rivers and streams.

## Plant windbreak trees

In exposed areas plants need protection from strong winds. If you are clearing new land, try to leave belts of scrub. In previously cleared areas plant windbreaks of suitable trees. They give protection from the prevailing south-east winds and help reduce damage from strong winds associated with storms and tropical cyclones. Windbreaks reduce leaf tearing and transpiration which in turn reduces the plantation's water requirements.


*Contacts*
Section 6 page 16

Leave at least 10 m between the windbreak and the first row of plants to allow machinery access and to reduce the competition for water and nutrients. Remember that tall trees are hazardous to aerial spraying. Seek advice on suitable windbreak species from Department of Natural Resources' forestry extension officers.

When planting windbreak trees, deep rip rows to at least 60 cm before planting. If ripping downhill, lift the toolbar every 15 m to prevent water scouring down the rip lines. Plant the trees 4 m apart and mulch

well with coarse straw. Regular applications of small quantities of a DAP fertiliser will promote rapid growth. Do not use high potassium banana fertiliser. Maintain a weed-free area around the trees for at least the first two years.

Deep rip about 1 m from the windbreak trees every two or three years to prevent root competition. This is best done in spring or summer.

Windbreaks may increase disease problems by increasing humidity through reduced air circulation.

## Plant spacings

### Planting layout

In north Queensland, bananas are grown as either single or double rows (Figure 6). A double row pattern can be achieved in two ways:

- two rows are planted initially, or
- a single row is planted initially and then two following suckers are selected on each plant in the plant crop. (This produces a double row arrangement in the next crop. The pattern is maintained by selecting a single following sucker on each plant in the subsequent crops.)

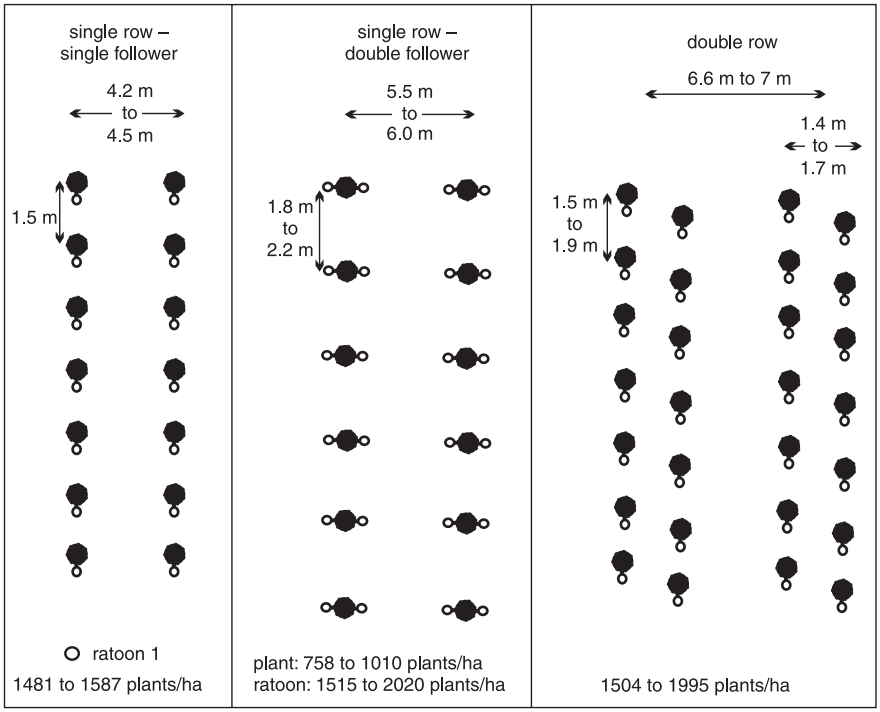



***Figure 6.*** *Planting patterns of bananas in north Queensland*

#### *Plant densities and their effects*

Bananas can be grown over a broad range of plant densities to achieve a similar yield per hectare per year. For the wet tropics this density ranges from 1500 to 3000 plants per hectare. The expression of yield

and plant growth, however, differs between the low and the high densities. The major effects are:

- increased density decreases bunch weight and finger length;
- higher densities extend crop cycle times, particularly in ratoon crops, from 8 to 12 months or longer;
- bunches are slower to fill at high densities, which is likely to reduce greenlife; (Greenlife refers to the time between harvesting and fruit ripening.)
- increased densities result in more variation in bunch size and time of harvest;
- higher densities retard sucker development and make it difficult to select following suckers of consistent size;
- increased density enhances leaf spot disease; (It is harder to get good spray coverage and airflow is reduced, resulting in slower drying of the leaves.)

Double row arrangements with plant densities of 1500 to 2000 plants per hectare are the most commonly used in north Queensland.

### *Choose the best spacing for your farm*

The best spacing is determined largely by soil fertility. More fertile soils produce larger plants, which means that a lower planting density will be necessary.

When deciding on the most suitable plant spacing for your plantation, consider:

- machinery access
- irrigation method
- level of crop uniformity
- crop cycle interval
- bunch size and finger length requirements
- disease incidence and control in wetter areas.

Here are some further points to consider.

**Follower selection.** Growers need more skill in follower selection to properly manage single row/double follower and double rows than single row/single follower.

**Spacing.** Spacings of less than 1.5 m in the row will lead to fruit damage because of contact with neighbouring plants.

**Density.** Higher densities will generally lead to increased costs of production per hectare due to greater cost of planting material, bunch covers and labour.

The plant spacing for your farm will need to be tailored to your individual requirements for each farm block and the climate.

## Planting material

### Regulatory requirements

a key issue

Legislation
Section 4 page 8

You must obtain a permit from your local DPI banana inspector or horticultural extension officer before planting bananas. This includes new blocks on an existing farm.

Planting bananas is controlled by the Banana Industry Protection Act which is administered by the DPI. The legislation is aimed at controlling the spread of bunchy top and other pests and diseases of bananas.

### The importance of 'clean' planting material

more info

*Problem solver*
Section 5

Serious pests and diseases such as Panama disease, bunchy top virus, banana streak virus, nematodes, rust thrips and banana weevil borer are spread in infested planting material. It is important that only clean (free from infestation by pests and diseases) planting material is used.

Clean planting material can be obtained by:

- using tissue-cultured plantlets
- only buying field-grown material from accredited sources
- producing your own material from tissue-cultured plantlets in a clean field nursery.

### Types of planting material

Planting material for commercial banana varieties can come from two sources.

**Vegetative planting materials** are pieces of plant corms (called bits) that contain 'eyes' or 'buds', or the small corms of advanced suckers (called suckers or bulbs) taken from established plants (Figure 7a, b).

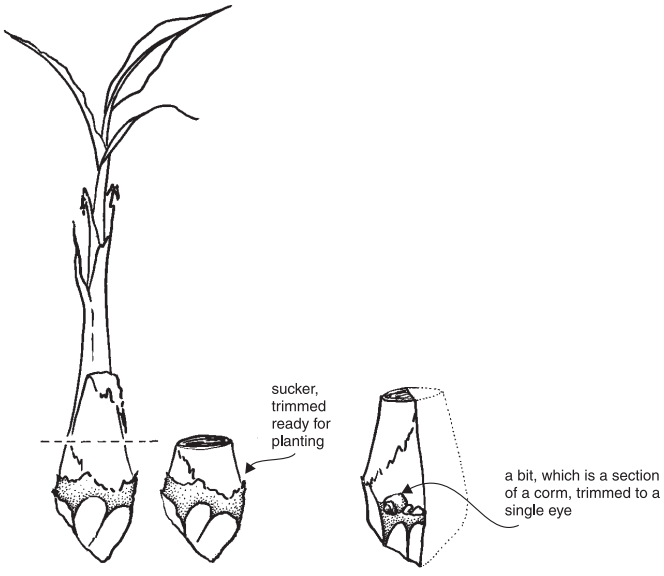



***Figure 7a.*** *Types of vegetative planting material*

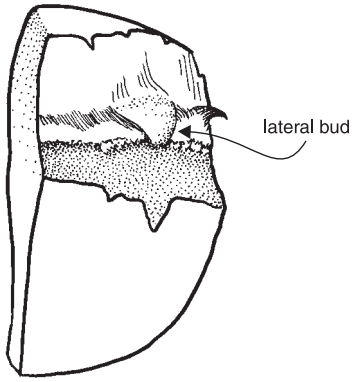



***Figure 7b.*** *A pared banana bit — commonly used planting material*

**Tissue-cultured plantlets** are grown in sterile conditions and sold in pots (Figure 8).

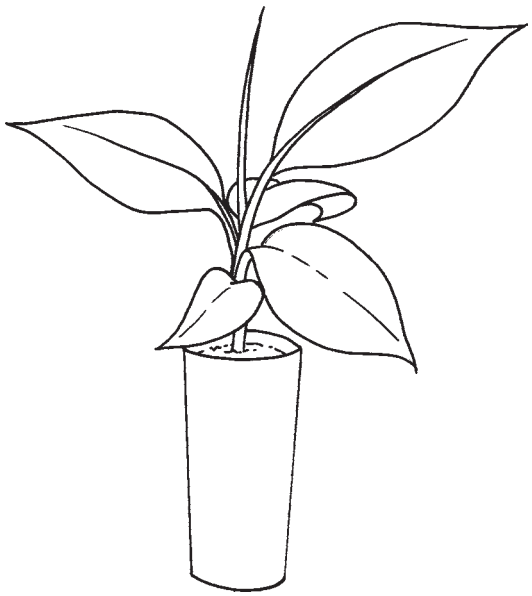


***Figure 8.*** *A potted tissue-cultured plantlet*

**Advantages and disadvantages of vegetative planting materials**

- Bits and suckers can remain in the ground and dug when required.
- Bits and suckers are about half to one-third the cost of tissue-cultured plantlets.
- There is a greater risk of spreading disease with bits and suckers.

**Advantages and disadvantages of tissue-cultured plantlets**

- Plantlets grown under QBAN accreditation are free of major pests and diseases.
- Uniform growth of tissue-cultured plantlets ensures that most plants are at a similar stage. This assists with desuckering, bell injection, bagging and harvesting.

- Plantlets must be ordered ahead of time and planted as soon as material is ready (unless potted out).
- Plantlets require frequent watering and more attention in the early stages of growth.
- Plantlets require a modified desuckering system and follow selection procedure.
- Several minor varieties are not available through tissue-cultured plantlets. Accredited field sources are the main source.

## Planting material nurseries


Growth stages of a banana plant
Section 4 page 6

Vegetative planting material may be multiplied by planting a field nursery. This enables growers to have control over production and timing of their planting material. The aim of on-farm nurseries is to provide clean planting material at a cheaper cost than tissue-cultured plantlets.


Fallow and replant
This section page 27

Establish nurseries with tissue-cultured plantlets on land that has never grown bananas, and does not receive soil and water runoff from banana land. If clean land is not available, choose land that has been fallowed from bananas for a few years with a suitable non-host crop. The nursery site should have no history of nematodes or Panama disease.

Nurseries established from tissue-cultured plantlets should not be dug for planting material until after the plants have bunched because of the risk of off-types. These mutant plants do not produce the required characteristics needed for commercial banana production and should not be planted.

## Preparing field planting material

The aim is to have sucker/bit planting material weighing between 0.5 and 1.5 kg. Each piece must have one prominent eye and should be free of nematodes, banana weevil borer, rust thrips and all serious diseases.

Select the preferred stage for digging. Recently bunched plants should yield 12 to 15 pieces. If left any longer, the stools become more difficult to dig and cut up.

Stools can be dug using a range of methods from crowbar, mattock and shovel to back-hoe tractors or specially built rippers with twin shank cutter bars. Methods used will depend on the soil type. In sandy loam soils, the stools will be easier to dig and wash than in heavy clay soils. Digging is easier in moist soil.

To produce pieces, remove as much soil as possible. A medium pressure, high volume water hose should be used as there is less damage to the eyes on the pieces. The suckers should be separated from the butt using sharp desuckering tools and sorted by size. Larger suckers with prominent eyes should be cut into pieces, each with one prominent eye.

The dissection of butts should be carefully planned to produce the maximum number of large bits, each with a prominent eye.

Bits and suckers should be pared to remove all roots and excess leaves (Figure 7b). Discard bits and suckers with signs of banana weevil borer or burrowing nematode damage on the corm.

The amount of labour and skill involved in the preparation of bits and suckers can be reduced by employing contractors. Alternatively, you can buy bits and suckers from accredited suppliers.

## Treating bits and suckers

Planting material is the most common method of spreading pests diseases. If your nursery is not clean, all bits and suckers should be treated for burrowing nematode with a hot water treatment or a fenamiphos (Nemacur) dip.

### Hot water treatment

The hot water treatment involves thoroughly immersing the planting material in a hot water bath at 53° to 55°C for 20 minutes. Pieces for treatment should weigh at least 1 kg.

Both the immersion time and temperature are critical. The best system is to use specially made tanks and baskets. You can also have large amounts treated at Cane Pest and Productivity Board facilities at some sugar mills. Treated pieces should be cooled, dried and then planted as soon as possible (Figure 9).

***Figure 9**. Dipping banana bits in a hot water bath*


### Fenamiphos dip

Dipping involves immersing the material in a dip of 100 mL of Nemacur 400 in 100 L of water at air temperature for 10 minutes. A 100 L solution should treat 500 bits.

Nemacur-treated material must be handled carefully, even when dry. Always wear suitable protective clothing and use gloves when handling and planting bits.

The Nemacur-treated material should be kept dry and cool, and then planted as soon as possible.

## Quality Banana Approved Nursery (QBAN)

QBAN stands for Quality Banana Approved Nursery. It relates to a set standard of pest and disease freedom for tissue-culture and field-grown nurseries. The standards are set by the banana industry through the Banana Industry Protection Board and are enforced by DPI plant health inspectors.

### QBAN — tissue-culture

more info
QBAN outlets
*Contacts*
Section 6 page 4

The standard procedure for tissue-culture nurseries starts with the selection and certification of the parent material, ensuring it is free of all serious diseases. The parent material is multiplied in laboratories that meet annual inspection requirements.

Plantlets produced from the QBAN laboratories are moved to nurseries that grow the plants in pots to a stage where they can be planted in the field. These nurseries have strict requirements and are inspected regularly. They produce vigorous, disease-free plants with less than 5% off-types.

### QBAN — field

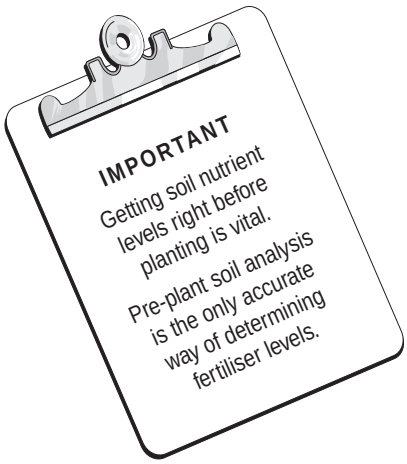
A QBAN inspection/certification system can also apply to field-grown planting material. Field nurseries are required to have a history of no major pests and diseases. During inspections samples are taken for confirmation of pest and disease freedom.

## Soil analysis and preplant fertilisation

more info
Laboratories
*Contacts*
Section 6 page 5

Get a soil analysis done to check the nutrient status of your soil. Soil sampling kits are available from your rural supply store and sampling directions are provided in the kits. Soil analyses are available through several analytical laboratories and fertiliser companies.

A complete soil analysis takes a lot of guesswork out of fertilising and good nutrition will help get the best yield and quality. Remember to allow about two weeks for the analysis and for the required preplanting treatments so that nutrients are available to plants.




The usual preplant fertiliser applications are lime and superphosphate/rock phosphate cultivated in a few weeks before planting, and nitrogen and potassium in the planting furrow. A general guide to preplant fertiliser applications is:

- 1.5 to 2.5 tonnes of lime or similar product per hectare incorporated into the soil in the initial land preparation phase;
- 25 to 30 kg of phosphorus (for example, 360 kg superphosphate) per hectare incorporated into the soil in the initial land preparation phase;
- 40 to 45 kg each of nitrogen and potassium (for example, 90 kg of urea and 90 kg of potassium chloride) per hectare placed in the bottom of the planting furrow. Ensure this is covered with enough soil to avoid direct contact with the planting material.

## Install the irrigation system

Bananas are irrigated with either overhead solid-set sprinklers, travelling irrigators or under-tree systems such as drippers and minisprinklers. Drippers and minisprinklers are better in areas with less water because they use water more efficiently and reduce yellow Sigatoka infection.

a key issue
Leaf spot diseases
Section 4 page 49

### Tissue-cultured plantlets

The irrigation system for tissue-cultured plantlets must be installed at planting to prevent plants dying from water stress.

## Planting

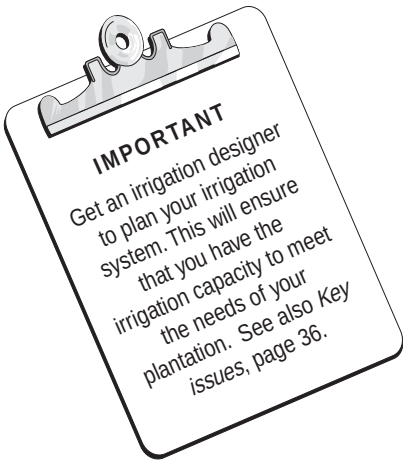
The soil is cultivated to a weed-free condition. This usually involves cross-ripping, ploughing and two discings. Use a v-blade or grader to form the cultivated soil into raised or mounded rows 0.6 to 1.0 m high. These mounded rows help with surface and subsurface drainage, particularly in flat areas, and help to reduce waterlogging.

Drills are then opened in the top of the mound to a depth of 30 cm. Planting pieces are placed in the bottom of the furrow and covered with about 15 cm of soil. The remainder of the furrow is filled in during early weed control cultivations. Filling in the furrow helps to improve the mound along the rows. Single and double row mechanical planters have been developed by modifying sugarcane planters. They greatly reduce the time required to plant.

A pre-emergent herbicide can be applied immediately after planting but there must be a minimum cover of soil over the planting bit otherwise it may be killed. The soil must not be disturbed after application of herbicides.

more info
Weed control
This section page 19

## Irrigation




### Bits and suckers

Bits and suckers are best planted into moist soil. Irrigation, if necessary, is not needed until after the plants have emerged.

### Tissue-cultured plantlets

Tissue-cultured plantlets have more critical water needs than bits and suckers. A suitable irrigation system should be in place at planting. These plantlets usually require watering immediately on planting out and this is most important during hot dry weather. Small amounts of irrigation will be necessary every one to two days during the first few weeks after planting, until the root system becomes established.

# Managing the crop

*There are two distinct stages in a banana crop — the plant crop, which is the first crop after planting, and the ratoon crops, which are the following crops resulting from suckers' growth. The management practices you should follow to grow a well spaced, healthy banana plant that will yield well are covered in this section.They involve, among other things, good sucker selection, control of pests and diseases and good fertiliser and irrigation management. There are nine key steps.*



## Irrigation

There are periods of the year when irrigation is critical and you will increase yield by irrigating during dry spells. Regular watering will improve some aspects of fruit quality.

Irrigation should be applied every three to ten days with overhead systems and every one to six days with under-tree systems. The difference between the systems is largely related to the amount of soil wetted. Plants require 20 to 60 mm of water a week, depending on the prevailing weather.

Growers determine when and how much water they apply largely from experience. Objective irrigation scheduling methods such as tensiometers can be used but most growers irrigate on an *ad hoc* basis.

## Fertilising

### Bits and suckers

If the land preparation recommendations outlined previously have been followed, additional fertiliser will only be necessary three months after planting. Mechanical broadcasting of fertiliser any earlier than this can result in fertiliser burn if granules become lodged in leaf bases.

From the third month onwards, regular applications of nitrogen and potassium fertilisers are required. About 400 kg of nitrogen and 600 kg of potassium are required per hectare per year when broadcasting. If you are applying fertiliser through the irrigation system (fertigating) these quantities can be reduced by up to 25%, but any reduction should be done in conjunction with regular leaf and soil analysis.


Soil and leaf analysis
Section 4 page 31

Apply broadcast fertiliser every four to six weeks or every one to two weeks if you are fertigating. Divide the yearly requirement equally between the number of applications. Phosphorus fertiliser at 50 kg/ha and lime or dolomite at 1 t/ha is broadcast at six monthly intervals. Trace element requirements, such as zinc and boron, are best determined by leaf analysis.

Soil and leaf tissue testing should be carried out once a year just before bunching. This monitoring procedure allows you to determine how effective your fertiliser application program has been and what changes might be necessary.

### Tissue-cultured plantlets

Fertiliser recommendations for tissue-cultured plantlets are the same as those for conventional planting material, but the basal fertiliser application is more vital to the crop's success. This is because tissue-cultured plantlets do not have the food reserves that are present in the corm of conventional planting material.

## Weed control


### Plant crop

#### *Conventional plants (bits and suckers)*

Weeds compete for fertiliser, water and light and harbour pests and rodents. They can also make it difficult to detect pests and diseases. Weed control is most important in plant crops. Weed control methods include cultivation, slashing and herbicides for pre-emergent and post-emergent control. Table 1 shows herbicides registered in bananas and their mode of action. As plants near their time of bunching, good leaf canopies reduce light and help to lower the incidence of weeds.

### *Tissue-cultured plantlets*

Good weed control is essential for tissue-cultured plantlets. Control relies on a combination of cultivation and post-emergent herbicides to maintain optimum growth of young banana plants.

As tissue-cultured plantlets are more sensitive than conventional planting material we do not recommend the use of pre-emergent herbicides.

### *Ratoon crops*

Weed management in ratoon crops relies on shading from the canopy, herbicides, slashing and to some extent trash placement. You may need specialist advice for some hard-to-control weeds.

***Table 1.*** *Registered herbicides for tropical bananas and their mode of action*

| Chemical | Weeds controlled | Products | Action |
|---|---|---|---|
| 2,2-DPA-sodium | Annual and perenial grasses | Altapon | Knockdown |
| arsenic | Most grasses and broadleaf weeds | Arsenite | Knockdown |
| diuron | Most grasses | Diuron<br>Diurex<br>Diugranz<br>Striker<br>Karmex | Pre-emergent |
| diquat + paraquat | Annual grasses and broadleaf weeds | Sprayseed<br>Tryquat | Knockdown |
| fluazipof-p | Annual grasses | Fusilade | Knockdown |
| glufosinate-ammonium | Most grasses and broadleaf weeds | Basta | Knockdown |
| glyphosate | Eradicates bananas | Roundup<br>Glyphosate<br>Glypho | Knockdown |
| haloxyfop-ethoxyethyl ester | Grasses only | Verdict | Knockdown |
| oryzalin | Some grasses and some broadleaf weeds | Surflan | Pre-emergent |
| paraquat | Most grasses and some broadleaf weeds | Paraquat<br>Gramoxone<br>Para-Di<br>Nuquat<br>Uniquat<br>Maxitop | Knockdown |

## Trash management

Regular deleafing and harvesting produces leaf and stem trash. Although the trash material rots quickly in the wet tropics, it will accumulate during the drier months and its appropriate placement is open to debate.

You should consider the following issues when deciding whether to place the trash in the plant row or the interrow area.

- Trash protects soil from erosion, helps retain soil moisture and impedes weed growth. Its break down increases soil organic matter.
- If most of the trash is allowed to accumulate close to the base of plants, it may encourage populations of banana weevil borer.

- Placement of trash close to the base of the plant can affect insecticide and nematicide applications aimed at the plant corm and surrounding soil.
- Trash in the plant rows can restrict ease of movement across rows during harvesting.

## Desuckering/sucker selection


Sucker selection
Section 4 page 19

Desuckering is the practice of removing unwanted suckers from the mother plant and leaving the sucker that you wish to become the next cropping plant. Removing unwanted suckers helps maximise yield and growth of the following sucker and mother plant by reducing competition for water and nutrients. Removal also benefits disease control by improving airflow.

The following sucker is usually selected when the mother plant is close to bunching. When choosing which sucker should remain, the following considerations are made.

- Choose sword-leaf suckers as only they have the required vigour to produce commercial crops.
- Try to maintain your row arrangement by choosing a sucker which roughly falls in line with the current rows. All the following suckers should be positioned on the same side of their mother plant to maintain the spatial arrangement.
- Try to choose following suckers of roughly the same size to maintain some uniformity of cropping. This becomes more difficult as a plantation ages.

### Desuckering methods

There are different methods of desuckering.

- Cut the unwanted suckers off about 20 cm above ground level and inject 2 to 4 mL of lighting kerosene or diesel into the centre of the stem just above the corm.
- Inject 0.5 mL of a 2,4-D amine solution (5% active ingredient) into the unwanted suckers. This is the fastest and easiest method of desuckering but it can damage the following sucker or mother plant if application is careless.
- Use a spoon-shaped gouge or desuckering shovel to remove unwanted suckers. This practice involves hard manual labour. It is often restricted to ratoon crops because suckers are usually too deep in the plant crop for the shovel or gouge to be effective.

### Tissue-cultured crops

Desuckering in banana crops established from tissue-cultured plantlets is slightly different from that for plantings established from bits and suckers. While the reasons for desuckering and the methods used are the same, the selection of the following sucker differs. This is because

the first crop of four or five sword-leaf suckers produced from tissue-cultured plantlets is not always suitable to be left for the first ratoon crop.

When choosing a following sucker in a tissue-cultured plant crop, the following considerations are made.

- Water suckers can be produced in the first two months of the plant's life. These suckers should be removed.
- The first four to five sword-leaf suckers should be removed as they have a poor connection to the mother plant. If this connection is broken the sucker loses vigour and produces a smaller plant and bunch. These four to five suckers should be removed early in the life of the plantation (at four to five months) when they are easily identified.

  If removal is left until later (close to bunching) up to 10 to 12 suckers may be present, making identification of the first four to five suckers more difficult. If all these suckers are removed at once, they can destabilise the mother plant as it prepares to bunch, making it more susceptible to falling over.

## Managing pests and diseases

more info
*Problem solver*
Section 5

Several major and minor pests and diseases attack various parts of the banana plant and can cause major and even total crop losses. Well timed and targeted treatments are required to protect the plant and its fruit. Good management of pests and diseases includes monitoring, timely spray applications and using an Integrated Pest Management (IPM) approach.

### Insect, mite and nematode pests

#### *Leaf pests*

The major leaf pest of plants is the banana or strawberry spider mite. Its development is favoured by hot, dry weather, particularly on plants suffering growth stresses. Biological control by the *Stethorus* beetle is the main control method. Cultural practices that prevent water stress help to reduce the impact of mite populations.

Some minor leaf pests are cluster caterpillar and grasshoppers. Chemical control is not recommended as the damage is mainly cosmetic and plants will grow out of it.

Greyback cane beetles may feed on the leaves from November to January. The damage is usually minor but severe defoliation by the beetles can expose bunches to sunlight, resulting in sunburnt fruit.

#### *Bunch pests*

In bananas the most important insect pests cause damage directly to the fruit. These pests are banana scab moth, rust thrips, sugarcane bud moth and flower thrips. They will be present in most new plantings on

the wet tropical coast. Control of these pests is based on injecting insecticide into the newly emerged flowers/bells and subsequent insecticidal treatment of bunches at bagging (Figure 10).


***Figure 10.*** *Injection of insecticide into the bell for early control of bunch pests*

### *Root and corm pests*

a key issue
Managing nematodes
Section 4 page 44

The two main root and corm pests are the burrowing nematode and the banana weevil borer. They are mainly spread in infested planting material. In infested plantations the populations of burrowing nematode and banana weevil borer can be expected to increase with time, making monitoring of their populations very important in ratoon crops. Chemical treatments should only be used where monitoring indicates that economically damaging levels have been reached.

High soil populations of cane grubs (larvae of the greyback cane beetle) can also cause some root damage to bananas.

## Diseases

### *Leaf diseases*

a key issue
*Leaf spot diseases*
*Section 4 page 49*

The main leaf diseases in Cavendish bananas are leaf spot (yellow Sigatoka), leaf speckle and cordana. Leaf spot is by far the major disease on the wet tropical coast as it is favoured by warm, moist conditions.

**Plant crops.** Leaf spot is not normally as serious in plant crops as it is in ratoon crops because:

- a large proportion of the leaf growth is in the drier months
- the smaller plant allows better spray coverage
- plant crops start cleaner because there is no carry-over infection from a previous crop.

Control measures include a combination of regular deleafing of diseased leaves and scheduled fungicide sprays. They should start with the detection of leaf spot in your plant crop or about three months after planting, if planted in early spring.

**Ratoon crops.** Management of leaf spot is more difficult in ratoon crops because the spread of harvest means that diseased leaves are present all the time. Additionally, some crops will make most of their leaf growth during the hottest and wettest period of the year when leaf spot infection and development is most active. Both chemical and cultural control measures are needed to control this disease.

Control measures for leaf spot will also control leaf speckle and cordana.


Consultants
*Contacts*
Section 6 pages 5, 9

Disease monitoring services are available from consultants. These services allow you to be better informed about decisions on disease control.

### *Fruit diseases*

The main fruit diseases develop after the fruit has left the farm. They are anthracnose/black end and crown rot. Maintaining good shed hygiene controls these diseases. This involves removing all leaf, fruit and flower scraps and cleaning down packing equipment with a chlorine solution each week.

Field diseases of fruit such as diamond spot and fruit speckle (Deightoniella) occur occasionally. They are most prevalent:

- during periods of wet weather
- in situations where air and water drainage are poor
- where deleafing is not practised.

### *Root and corm diseases*

The major corm disease of Cavendish varieties is Fusarium wilt (Race 4), also known as Panama disease. This disease does not currently occur in Queensland north of the Bundaberg region. Strict regulation of movement of planting material aims to maintain freedom from this disease in north Queensland.

**Soft rots.** Bit or sucker planting material may develop soft rots when they are planted during very hot conditions with heavy rain or irrigation soon after.

In some ratoon crops bacterial (Erwinia) corm rot may develop after the plant has experienced heat and water stress followed by heavy rain which causes waterlogging.

## Bird and animal pests

Birds and animals may cause considerable damage to fruit. The damage appears as scratches on fruit where nectar-feeding birds and bats hang while feeding, or from the feeding and scratching marks

caused by rats nesting in bunches. Many native birds and animals are protected species. You need special permits from the National Parks and Wildlife Services for their control.

## Bunch covering, trimming and support

### Bunch covering

Bunch covers (Figure 11) are used to:

- increase yield; (Covers increase fruit length and reduce the time to harvest.)
- improve fruit quality; (Covers improve colour and reduce mechanical damage in the field and during harvesting and transport to the packing shed.)
- help retain protective insecticide applications.

Thick bunch covers give better protection against birds and bats and are often reused four to five times before replacement. 'Single-use' bags are also available. They are thinner and cheaper than normal bunch covers and simplify management by eliminating the risk of workers using contaminated bags.

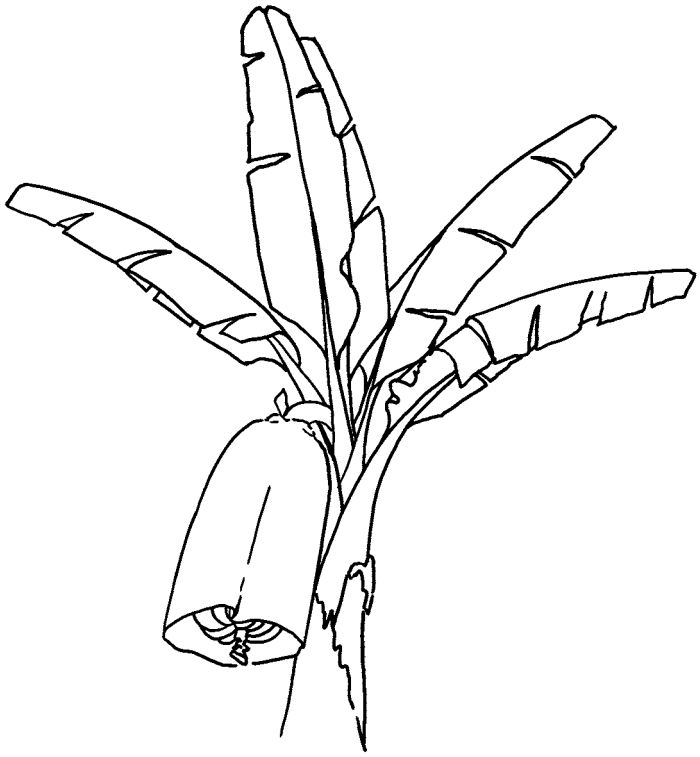


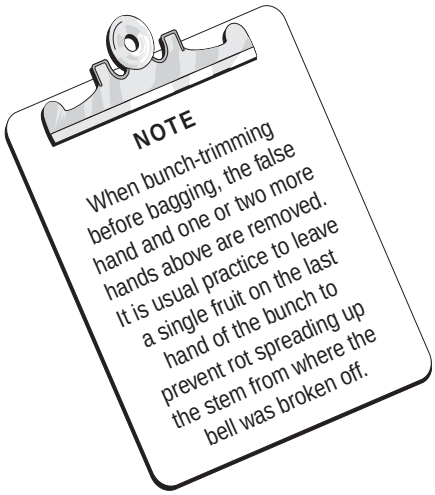
***Figure 11.*** *A correctly bagged bunch*

For the variety Williams, the bags are usually tied or stapled in place over the bunch as soon as the fingers begin to curl. Bagging earlier (before the bracts lift) is sometimes necessary because the flowers can be attractive to nectar-feeding birds and bats which scratch the fruit while feeding.

The use of 4WD bagging machines makes it easier to apply bags, treat bunches with chemicals, trim them and apply twine for bunching support.

## Bunch trimming

Bunch trimming is the removal of the bottom hands and the bell from a bunch at flowering (Figure 12). This is done to remove smaller, unwanted grades of fruit that develop on the bottom of the bunch. Removing the bell early can slightly increase overall bunch weight and remove feeding sites for bunch pests like scab moth, flower thrips and nectar-feeding animals.



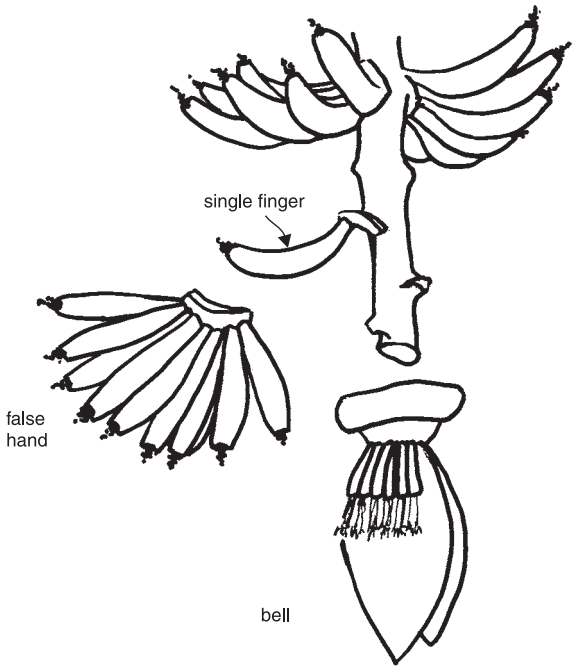




***Figure 12.*** *Removal of smaller hands and the bell during bunch trimming*

## Bunch support

Most commercially grown Cavendish varieties require support to prevent the bunched plant from toppling during wet and/or windy conditions. The most common method is tying the bunched plant with polypropylene twine. On farms where a bagging machine is used, the bunched plant is tied up when the bunch is bagged, trimmed and treated with insecticide. Where ladders are still being used, tying is usually done as a separate operation.

When tying in double rows, a length of twine is tied from high in the throat of the plant to the bottom of two well developed adjacent plants (Figure 13).

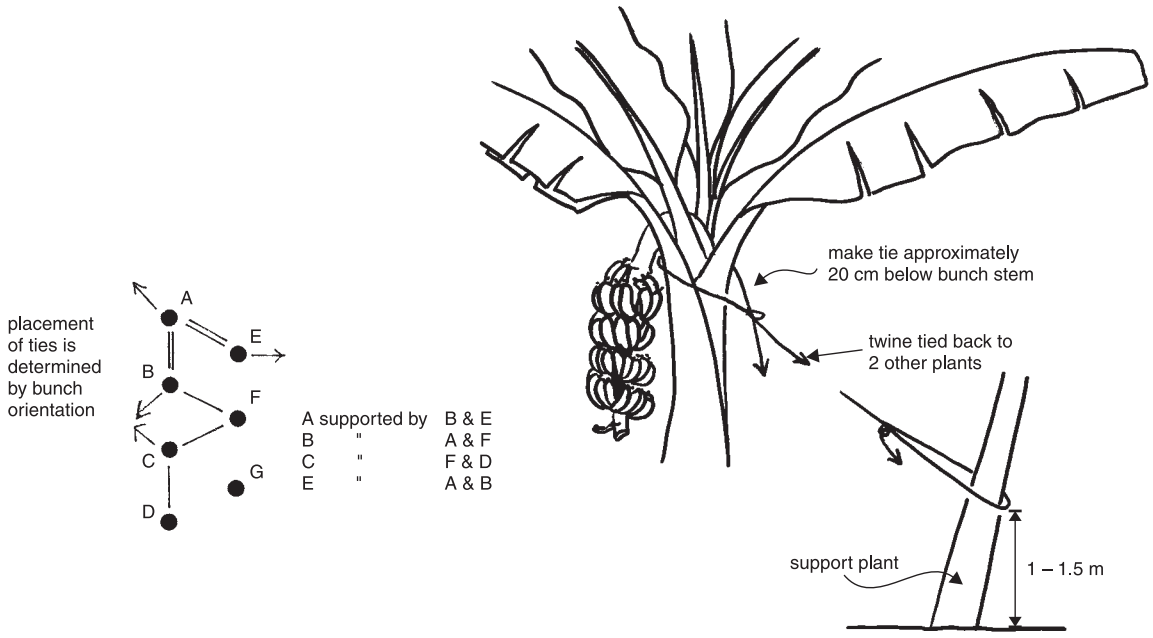



***Figure 13.*** *Positioning of string and a suggested pattern for tying plants*

## Fallow and replant

a key issue
Fallowing
Section 4 page 47

The usual life of a plantation in north Queensland is five to seven years, which means six to eight crops. Growers must decide at what point the declining productivity justifies the expense of fallowing and replanting. The economic life of a plantation depends on:

- decline in soil fertility
- build-up of pest or disease levels
- loss of stools (from wind, pests, diseases)
- lack of row alignment over time (leading to restricted machinery access)
- ability to schedule the crop for seasonal price fluctuations
- crop uniformity.

a key issue
Nematode
management
Section 4 page 44

Fallows start when banana plants are cut down and ploughed into the soil. It is most important that all banana corm material below the soil is decomposed and this usually takes six months. This will reduce the risk of any pests or diseases infecting bananas that are replanted in the same area. A fallow crop should be grown and kept free from volunteer banana plants. The aim of fallowing is to restore the fertility status of the soil and to break nematode and other pest cycles.

## Eradication of unwanted plants

A large tractor trailing a set of discs or a plant roller can be used to remove large scale plantings on relatively flat ground. For mature plants you will need a wheel tractor of over 60 kW or a medium sized track machine. The plants are pushed over and the disc/rollers chop and bury the corm, stems and leaves. This operation needs to be repeated until all plant material is broken down. It is beneficial to run subsequent discings in different directions.

# Harvesting and marketing

*Banana bunches are harvested when mature so that the fruit reaches the market in a hard green condition. Fruit is then artificially ripened with ethylene gas before being sold on the retail market. It is important for product quality and maximum shelf life that this harvested fruit has uniform maturity. This allows all fruit in a ripening room to be brought to a uniform degree of ripeness for sale.*



## How long does it take for a bunch to mature?

Depending on the season and cultural practices, especially irrigation and plant density, it may take from 10 to 14 months from planting to harvest. Subsequent ratoons are harvested about every 8 to 11 months.

The time taken from bunch emergence to harvest is 100 to 150 days. Bunches that emerge at the beginning of the cooler period (April) take the longest time from emergence to harvest. The shortest 'hang' period is for bunches that emerge during late spring and early summer (October to December).

## Assessing bunch maturity

Bunch maturity in any single planting of bananas is not uniform. Harvesting is usually spread over two to three months in plant crops and becomes progressively longer with each ratoon crop.

Traditionally, the time of harvest has been decided subjectively by the grower and is based on the degree of 'fullness' of the fruit. This term describes the angularity of the fingers, with rounder fingers being more mature (fuller) than angular fingers.

The rate at which a bunch fills, however, is greatly reduced by moisture stress, leaf spot damage or cooler weather. This makes 'fullness' of the fingers an unreliable guide to harvest maturity because such fruit ripens naturally at a smaller diameter than well grown fruit. Thus fruit from bunches which have grown more slowly may not arrive at market in a hard green condition if fullness is the only guide to maturity.

To overcome this problem a combination of fruit age and grade (fullness) is practised. This involves measuring fruit diameter and setting a maximum time limit or age for the fruit to reach a set diameter. If fruit does not reach this diameter within the specified period, it is harvested, or cut down and chopped up on the ground.

To achieve age and grade control you must record bunch age. This can be done by painting trees with different colours and symbols at the time of bell injection, or by regularly using different coloured bunch covers. The main objective of age recording is to ensure bunches are identified at the same stage.

## The harvest process

Bananas are harvested by hand, usually as a two-person operation with one person cutting and the other carrying. A common number for a harvesting crew is five, consisting of two teams of two people and a tractor/trailer driver.

To cut a bunch, make a shallow criss-cross cut with a cane knife in the stem facing the bunch. The weight of the bunch causes the stem to kink, the bunch is lowered to the carrier's shoulder and the bunch stalk is severed. Bunches are loaded in an upright position on a tractor-drawn trailer that is padded with foam rubber covered with plastic or vinyl. Pads are also used between rows of bunches.

In the shed, bunches are unloaded from trailers, the bunch covers removed and bunches washed before dehanding. There are many variations and systems for unloading and hanging bunches.

## Dehanding and packing

The hands of fruit are usually cut from the bunch stalk with a thin, straight-bladed knife, and obviously damaged or undersize fingers or hands are removed. The fruit is then placed either on a packing wheel or into a water trough/conveyor system where it is graded and sorted for size and quality defects.

Bananas are packed as whole hands, part hands or clusters in fibre-board cartons with a plastic liner (Figure 14). Plastic slip sheets are

used between full hands and absorbent paper is placed in the bottom of the carton. The carton must reach market with a net weight of 13 kg, so 13.5 to 13.75 kg of fruit is usually packed into each carton. The grower's name and address must appear on the end of the carton (Figure 15).

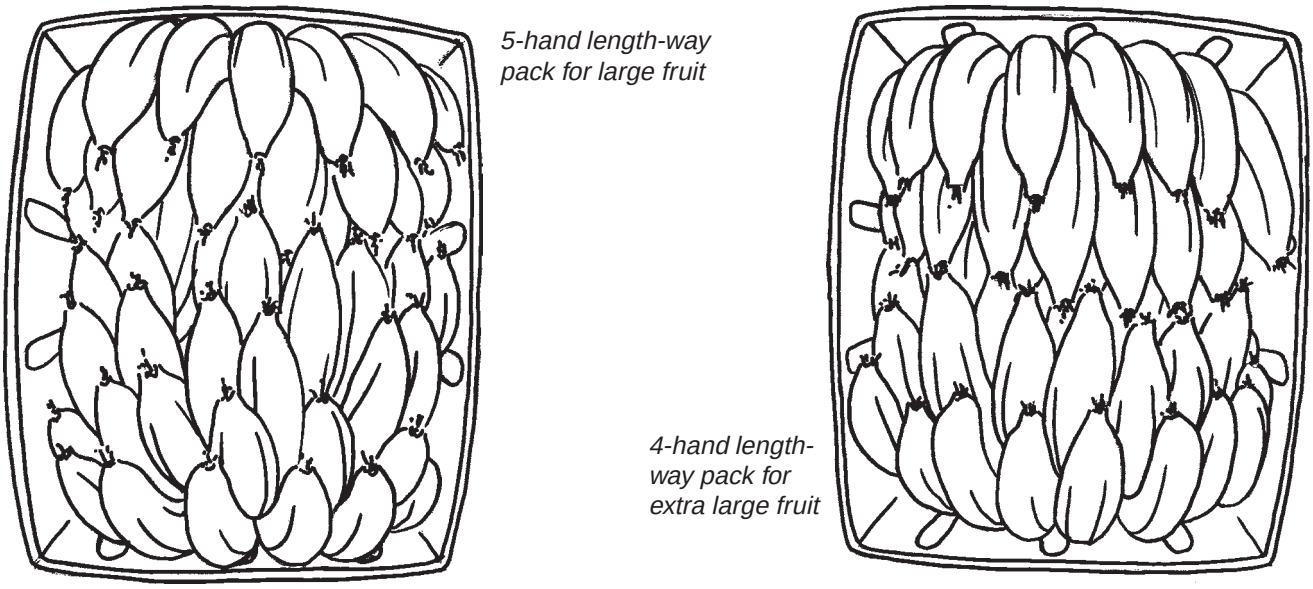



***Figure 14.*** *Examples of packing patterns for bananas*

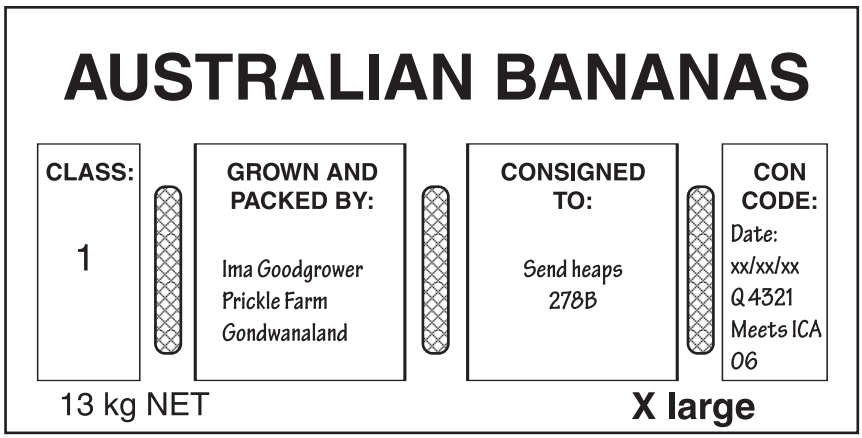



***Figure 15.*** *An example of end panel labelling for a standard banana carton*

After packing, the cartons are stacked on pallets. Glue and strapping is used on some of the layers to improve stability. Hydraulically operated pallet stackers are becoming common in packing sheds. They improve shed efficiency and address some workplace health and safety issues. A diagram of stacked pallet is shown in Figure 16.

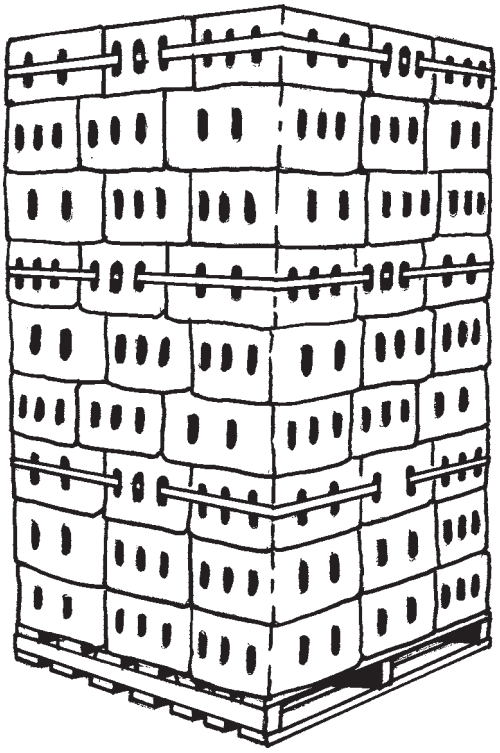


***Figure 16.*** *Stacking pattern for a pallet. Column stack the first three layers and interlock each alternate layer up to nine layers high*

## Fruit grades

There are three fruit grades, depending on finger size, for Cavendish. Length is measured from the tip of the fruit to the end of the fruit stalk on the outside curve. Circumference is measured at right angles to the curve of the fruit, where its diameter is greatest. The grades are:

- extra large (at least 200 mm long and 115 mm in circumference)
- large (177 to 200 mm long and at least 108 mm in circumference)
- medium (140 to 177 mm long and at least 101 mm in circumference).

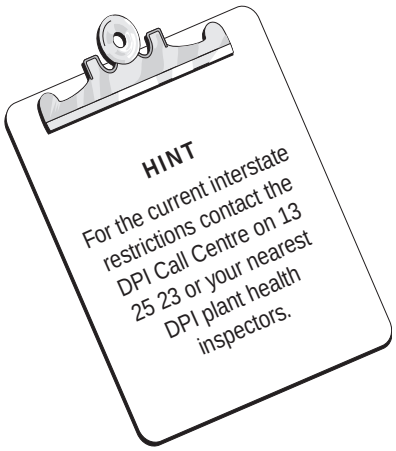
In practice, growers pack considerable quantities of extra large fruit as large, and large fruit as medium. The usual cut-off length between extra large and large is closer to 230 mm.

## Transport

Fruit is transported to the southern markets as palletised loads, mostly by refrigerated semitrailers. While the number of farms with cold storage facilities is increasing, most fruit is cooled at transport depots with cold stores before dispatch.

## Restrictions on interstate fruit movement

Some restrictions apply to the movement of banana fruit interstate, and sometimes within Queensland.




## Marketing

Apart from a small quantity for local consumption, most bananas are sold in the southern capital cities. The more distant markets are only four or five days away by road transport. There is no significant export trade at present.

For most farms the marketing system involves supplying their fruit to a preferred agent in the capital city wholesale markets. The agent takes delivery of the fruit and arranges ripening. When ripe the fruit is presented for sale. The price is set by what the buyer is prepared to pay and is influenced heavily by the availability and quality of bananas and of other competing fruit. For this process the agent takes a percentage of the sale price.

The major retail purchasers are chain stores, who buy about 75% of the bananas produced in Australia. Because of the volume of produce they require, they prefer to buy from suppliers of large volumes of consistent quality product. The remaining 25% of production is bought by independent retailers.

### Marketing cooperatives


Average prices
Section 1 page 6

Banana growers' cooperatives are new to Queensland. The North Queensland Banana Growers Cooperative Association Ltd was established about three years ago to improve the price growers received in the market place. About 15% to 20% of fruit from north Queensland passes through the cooperative.

Cooperative or group marketing negotiates freight and pricing on behalf of growers. Marketing groups charge a brokerage fee, often on a carton basis, for marketing services. These services often include independent quality and out-turn reports.