

Subtropical banana information kit

Reprint – information current in 2004



REPRINT INFORMATION – PLEASE READ!

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This publication has been reprinted as a digital book without any changes to the content published in 2004. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research: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- Financial information—costs and returns listed in this publication are out of date.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 2004. 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 subtropical banana production. 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

Chapter 3



Growing the **CROP**

This section is our recipe for growing and marketing a commercial crop of subtropical bananas. To keep the section as brief as possible and easy to follow, we give 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.

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Steps involved in harvesting, postharvest handling and marketing

The banana plant

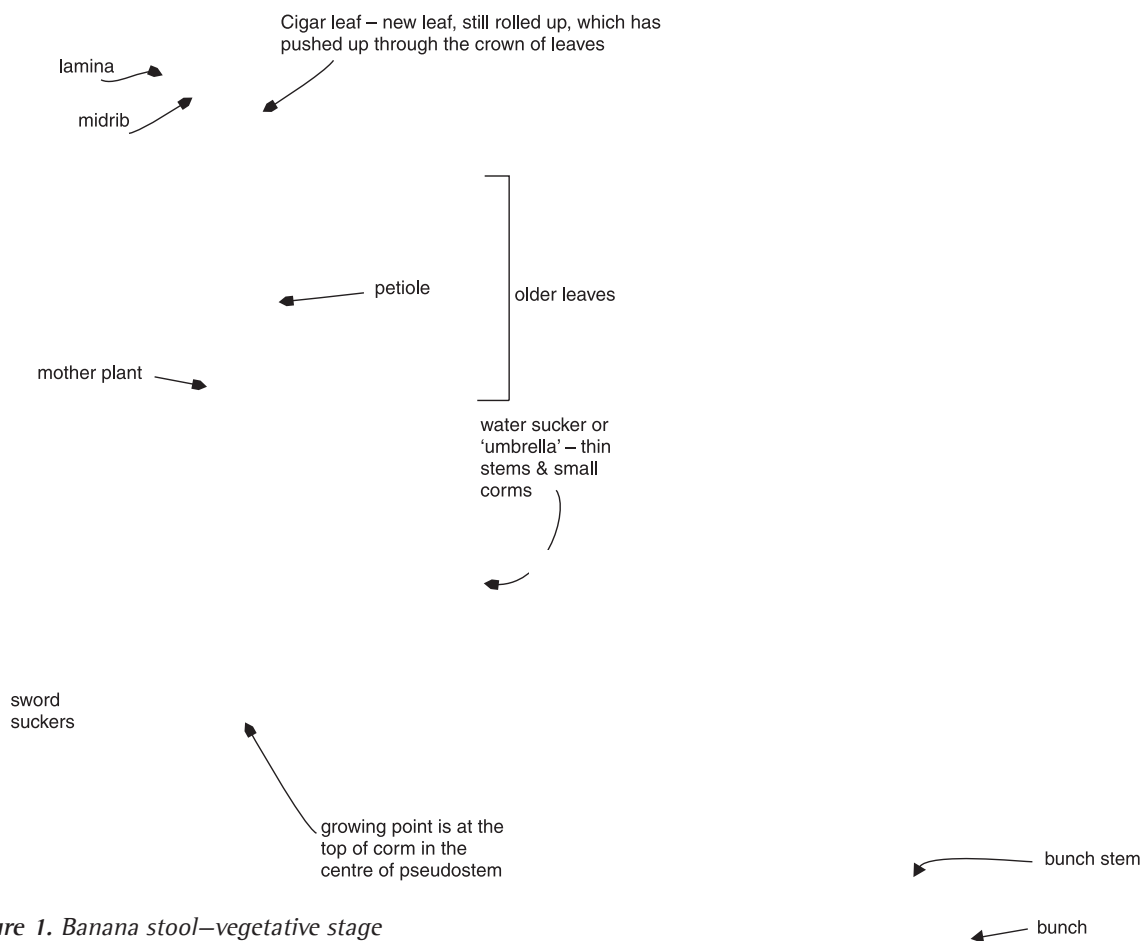


Figure 1. Banana stool—vegetative stage

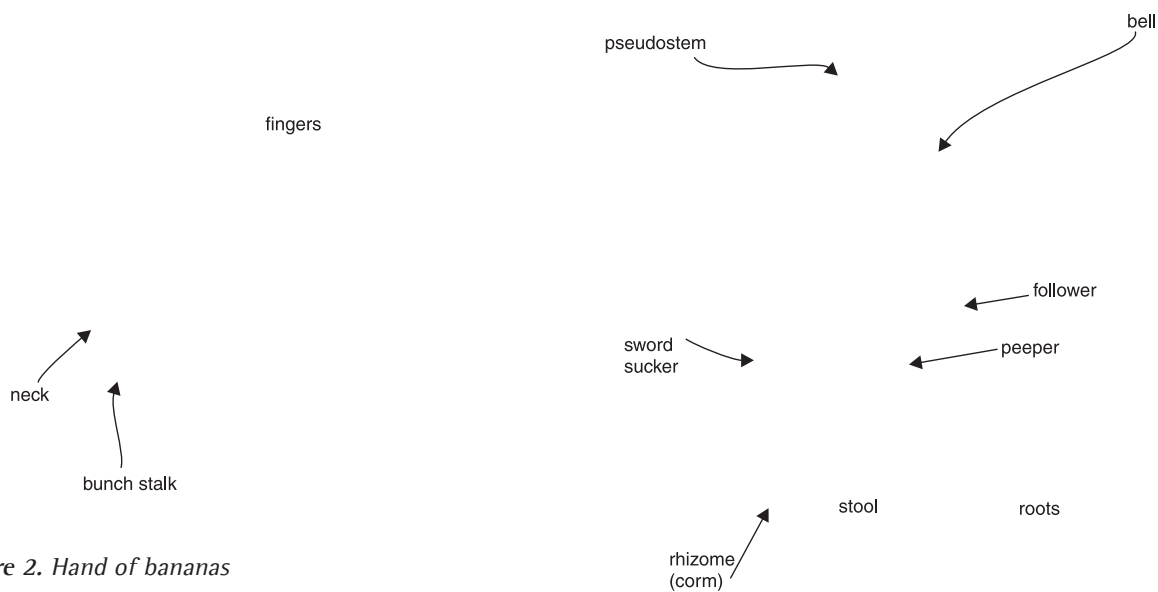


Figure 2. Hand of bananas

Figure 3. Banana stool—reproductive stage

Legal requirements

Why the regulations?

The Australian banana industry faces serious threats from a range of destructive pests and diseases. Strict controls on the movement and planting of bananas help to prevent the spread of serious banana diseases such as Banana Bunchy Top Virus, black Sigatoka and Fusarium wilt (also known as Panama disease). To protect the industry against the introduction and spread of pests and diseases between regions within Australia and from overseas, special legislation exists in both Queensland and New South Wales. These controls are also used to prevent the planting of pest bananas (ornamental and other bananas that are not used to produce edible fruit).

Regulatory requirements

The previous system of DPI Queensland accreditation of planting material sources no longer exists. In Queensland the planting and movement of banana plants is now controlled by the Plant Protection Regulation (No.1) 2002, which is subordinate legislation under the *Plant Protection Act 1989*. Under this regulation, all growers must obtain an 'Inspector's Approval to Move and Plant Bananas' before planting any banana plants. When approval is granted, the planting material supply will be assessed to make sure it is free of notifiable pests and diseases.

This legislation is administered in Queensland by the Banana Industry Protection Board. In New South Wales, legislation administered by Bananas NSW effectively controls the movement, planting and growing of all bananas.

In Queensland, the *Plant Protection Act 1989* limits the growing of bananas in home gardens. Note that Cavendish bananas are not permitted. Residential plantings are limited to a maximum of 10 plants with a maximum of 30 stems but you **must** have an inspector's approval. The varieties you are permitted to grow in a residential block are also restricted. Permitted varieties are listed in the table below.

In New South Wales, there are no restrictions on numbers of plants that can be grown in home gardens and Giant Cavendish types are approved with a permit.



Legislation
Key Issues page 66

Table 2. Permitted varieties for residential growing in Queensland

Location	Permitted plants
Far northern, northern buffer, northern & southern buffer quarantine areas	Plants listed in schedule 3 of the regulations: Blue Java, Bluggoe, Ducasse, Goldfinger (FHIA-01), FHIA-02, Goly Goly Pot Pot, Kluai Namwa Khom (Dwarf Ducasse), Pisang Ceylan (Mysore type), SH-3436, Simoi, Tu-8, War War, Yangambi Km5
Special and southern pest quarantine areas	Blue Java, Bluggoe, Ducasse, Goldfinger (FHIA-01), Kluai Namwa Khom (Dwarf Ducasse), Ladyfinger, Pisang Ceylan (Mysore type).

Industry regulations

Other legislation regarding the banana industry covers movement of soil and appliances, notifiable pests, levies, quarantine areas, pest control, disease control and weed control. New banana regulations were enacted in 2002, resulting in several changes to the requirements for banana growers.



Getting the plantation started

Setting up a profitable long-term banana plantation requires careful planning and development. Whether it is establishing a new plantation or replanting an existing one, mistakes made at this stage are difficult and costly to correct. You need to start planning your plantation and thinking about your marketing options well before the crop is planted. Legislative requirements must be addressed and a business plan prepared. There are thirteen key steps:

- Make sure the site is suitable
- Clear the land leaving appropriate windbreaks
- Plan plantation layout
- Prepare the site
- Choose varieties and plant density
- Order the plants
- Prepare the field planting material
- Plant windbreak trees to supplement standing timber
- Do a soil analysis and apply required fertilisers
- Grow a green manure crop
- Mark out the rows
- Install the irrigation system (where appropriate)
- Plant

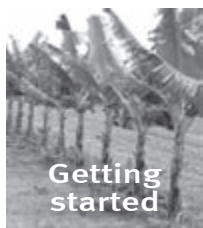


Figure 4. A frost-free, protected site facing north-east

Make sure the site is suitable

You need a frost-free site, preferably on warm, well-protected slopes with well-drained, clay loam soils at least 0.5 m deep and a north to easterly aspect protected from cold westerly and southerly winds (Figure 4). Frosts will kill leaves and sometimes plants. Periods of cold weather with temperatures below 13°C can cause chilling injury to fruit and damage plants.

The cost of developing and managing bananas rises significantly as slopes increase. Slopes greater than 15% are generally un-economic for growing bananas.



Clear the land leaving appropriate windbreaks

Permits are required for land clearing in both Queensland and NSW and there are restrictions on the steepness of land that can be cleared and planted. These limitations vary depending upon the vegetation and soil types. The Department of Natural Resources and Mines (DNRM) in Queensland or Department of Land and Water Conservation (DLWC) in New South Wales will advise whether you need to make an application before clearing land.

Approval to clear native vegetation is required in most cases. Also check with your local authority to find out what other restrictions apply.

Start any land clearing at least 12 months before planting to allow time for roots and remaining tree residue to properly break down before planting. Seek professional advice from DNRM and DLWC, then clear and stickrake or cutterbar the land. Push the timber into windrows across the slope for burning. Don't push it into gullies and depressions. Leave gaps in windrows every 30 m to allow safe removal of runoff water. Aim to complete stickraking, cutterbarring and burning operations at least six months before planting.

Clearing of scrub is best done during April or May to allow as long as possible for the felled timber to dry out before burning in September or October. This also reduces the risk of rain-induced erosion during wet summer months. On replant land, lantana and young saplings are cut down six weeks before burning. Old pastureland can be ploughed across the slope.

Before clearing, identify and mark strategically placed existing stands of timber to act as perimeter windbreaks. Ensure that adequate standing timber is left as a windbreak.

Establish a suitable cover crop. It is very important to do this at the earliest opportunity, before wet summer months threaten soil erosion (Figure 5).



Figure 5. Cover crop with rows prepared across the slope ready for planting

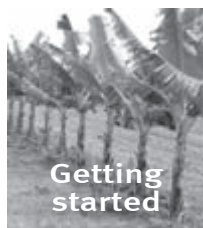


Land conservation
extension officers
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In NSW the DLWC can assist with plantation design and give advice on roadways, water courses, dams, windbreaks and cover crops.

Plan the plantation layout

Design of the plantation is particularly important as some subtropical banana plantations are established on relatively steep slopes. The steeper the slope the greater the risk of serious soil erosion, loss of production and difficulty in getting all-weather access to the crop. Seek expert advice from soil conservation consultants to help with plantation design and layout.



The publication, *Trees for the NSW North Coast* is available from the NSW Agriculture's Orange office. Contact: The Cashier, NSW Agriculture, Locked Bag 21, Orange NSW 2800
 Ph: 1800 028 374
 Fax: 1800 642 065

The aim of a well-planned plantation layout is to achieve maximum productivity with minimal environmental impact by following these guidelines.

Provision for windbreaks. Protect plants in exposed areas from strong wind damage which reduces fruit yield and quality. With major damaging winds coming from the southeast, south and west, windbreak protection on at least these sides of the plantation is essential. The best option is to use existing stands of timber, otherwise windbreaks may have to be established before planting. Expert advice on windbreaks is available from tree-care officers of DNRM and DLWC.

Slopes. Slopes 15% or less are preferred as these are less prone to soil erosion, do not trap cold air, allow flexibility with row layout and enable tractors and machinery to be operated more safely across the slope. Slopes greater than 15% should be avoided even where land clearing regulations permit this to be done. However, replanting on these slopes on land that has previously grown bananas is common especially in NSW. Where this is necessary, you should contact the DLWC for assistance with plantation design and layout. Note that pests and diseases such as Panama disease often remain in the old soil for many years and will affect new plantings.

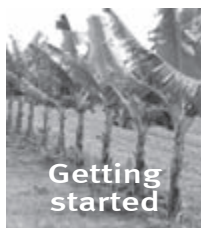
Surface drains. Drains are essential to control large amounts of runoff from high intensity rain that removes topsoil and nutrients and to avoid ponding of water. A drainage system normally consists of a diversion drain or bank above the plantation, cross-slope drains within the plantation and down-slope stable waterways to carry the water to a dam or watercourse.

Diversion banks prevent runoff water entering from outside the banana block by diverting excess runoff into a stable watercourse or grassed waterway. They should be established before the plantation is developed.

Cross-slope drains or contour mounds carry water slowly across the slope to decrease erosion. Use a grader, v-blade or ditcher to build contour mounds. Mounds on steeper land tend to look like terraces unless the row spacings are very wide. Terrace-like mounds with steep batters are both unstable and cause problems harvesting bunches and destroying the old stool when ploughing out.

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

Row direction and length. On slopes of up to 4%, rows can be run across or up and down the slope without any soil erosion control structures within the plantation. On slopes of 4 to 15%, rows can be run across or



up and down the slope but drains are required between the plant rows to control runoff water. If rows are run across the slope, locate the rows and drains as close to the contour as possible with a fall of 2 to 5% to safely remove water. If rows are run up and down the slope, contour drains are required at least every 50 m down the slope to intercept and remove accumulated runoff water.

Watercourses and dams. Gullies, creeks and depressions should be disturbed as little as possible. Leave a buffer of trees along gullies and creek banks to keep them stable. Do not plant trees where runoff naturally concentrates in gullies or depressions. Seek professional advice on dam siting and construction from water field officers of the DNRM and from irrigation officers of NSW Agriculture.

Roadways. It is important to have all-weather access to the plantation for spraying, harvesting and other operations. Locate access roads on ridgelines and on the contour wherever possible. Use contour drains to move runoff from fields away from access roads to stable watercourses or gullies. Figure 6 shows the four main parts of a contour system (diversion banks, contour mounds, grassed waterways including watercourses with riparian vegetation, and access roads)



Environmental issues
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Benefits from a good plantation layout

There are a number important benefits to be gained from a good plantation layout:

- Higher yields due to reduced losses of soil and plant nutrients including fertiliser.
- Less maintenance of roadways and inter-row passageways required.
- Essential machinery operations for various aspects of crop management are less restricted following heavy rain because of better access.
- Minimised postharvest bruising in transit to the packing shed because of better access roads.
- More efficient use of irrigation systems due to more even pressure distribution along contoured banana rows.
- More efficient use of available water, particularly during drier periods.
- Improved drainage of wet areas.
- Reduction in chemical and sediment pollution of rivers and streams.

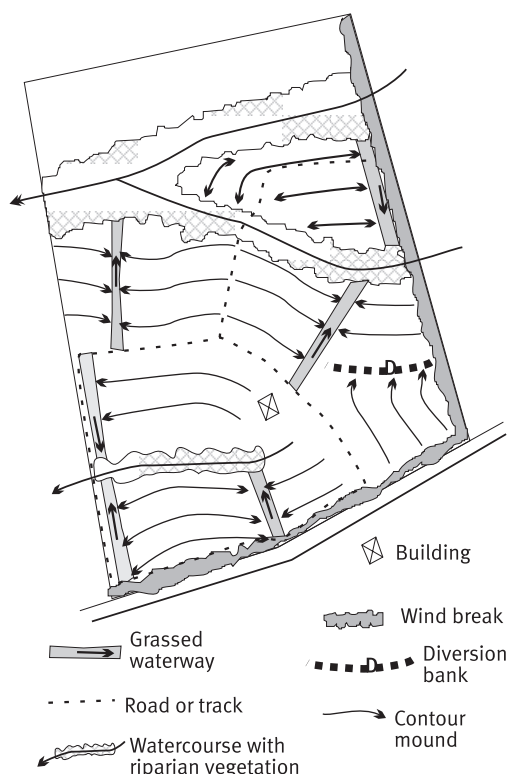
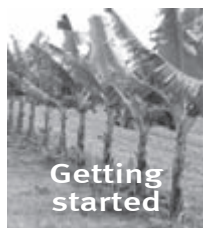


Figure 6. Runoff control plan for a banana plantation (Courtesy of NRM Facts: Erosion control for bananas)



Prepare the site

In preparing the site, minimise soil erosion by disturbing as little of the ground as possible and leaving as much plant residue on the surface as you can.

Deep rip

Deep ripping improves drainage and enhances root penetration. Rip newly cleared land to break up remaining tree roots, and where a plough pan or hard layer exists in heavily cultivated land. Ripping also helps with the drainage of wet areas where springs occur.

Where necessary, deep rip the site to a depth of at least 60 cm preferably across the slope on the contour. If ripping downhill, lift the ripper for a metre or two every 30 to 40 m to avoid subsequent water erosion down the rip lines.

Roads

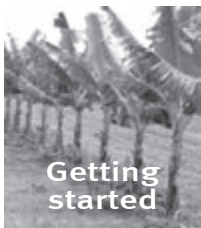
Construct roadways three to four metres wide to allow for the movement of spray equipment and harvesting trailers without damaging the crop. Always shed runoff from fields away from access roads, using contour drains to move this water to stable watercourses or gullies. Concrete pipes may be needed where roads cross major drainage lines. Concrete or rock inverts are ideal for dam spillways and other regular crossing points. Use speed bumps to catch and divert water safely off the roads. In most situations, these should be no more than 50 m apart and are best located where slope changes or suitable water outlet points are available.

Contour drain above the plantation

Construct a contour drain above the plantation to divert water into a stable waterway or dam. The drain should run at a gradient of 1 to 5% and be large enough to handle the water from the catchment above. Unless you have very stable soil such as heavy clay, keep the steepest sections of the drain furthest from the waterway or dam.

Contour mounds within the plantation (up to 15% slopes)

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

Use a grader, v-blade or ditcher to build contour mounds to a height of 30 cm (Figure 7). The minimum height after settlement should be 20 cm.

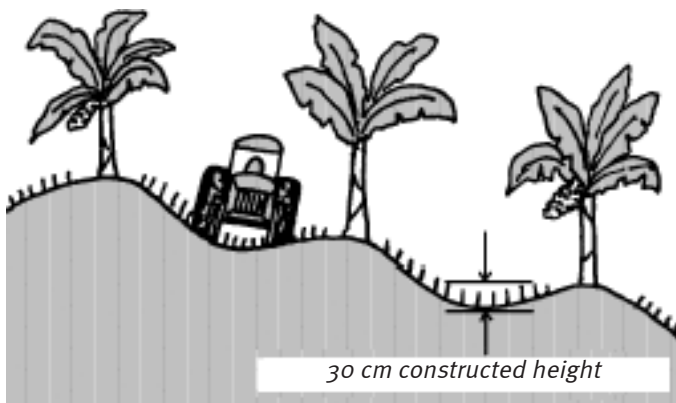


Figure 7. Transactional view of contour mounds—single row planting

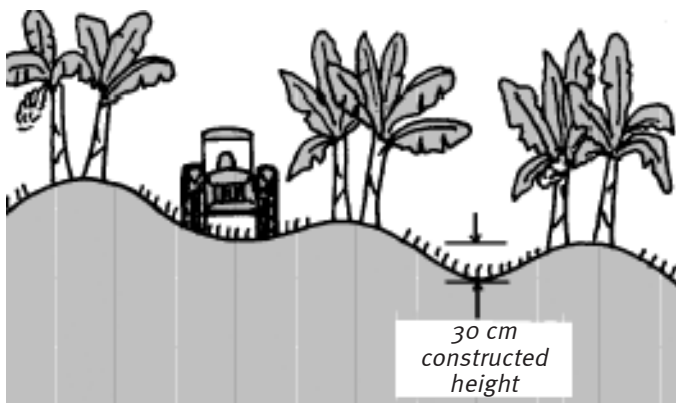


Figure 8. Transactional view of contour mounds—double row planting

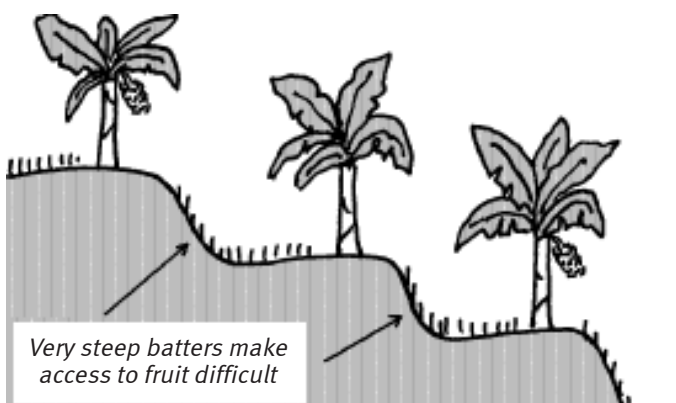


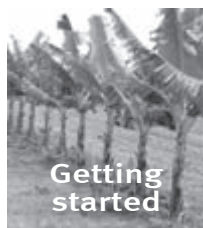
Figure 9. Transactional view of contour mounds—terraces

The mounds can be made wide enough for double rows of bananas on land with a slope of less than 6% (Figure 8).

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 (Figure 9). Terrace-like mounds cause problems in reaching bunches when picking and in destroying the old stool when ploughing out.

Stabilising drains

Waterways should be immediately grassed and stabilised. Grassing waterways can be difficult. Lack of rain can prevent seed germination or too much rain can cause wash-outs of recent grass plantings so irrigation may be necessary 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.



Choose varieties and plant density

Varieties

The main varieties grown in subtropical banana growing areas are Cavendish types (Williams and Mons Mari varieties) and Ladyfinger. Table 3 lists the important characteristics of these varieties.

Table 3. Characteristics of main varieties

Variety	Growth and production	Advantages	Disadvantages
Giant Cavendish: Williams, Mons Mari	Grows to 3.5m Produces 7 to 14 hands in bunches of 25 to 60 kg	<ul style="list-style-type: none"> • Best yields per hectare. • Standard market variety. • Subtropically grown cavendish are reported to be better tasting by some consumers. • Subtropical fruit tends to be smaller which is preferred by some consumers. 	<ul style="list-style-type: none"> • Strong competition from tropical growers who produce at lower cost. • Require propping, more fertiliser, more pest and disease control. • Best grown with irrigation. • Better suited to tropics and often show 'choke throat' under cold and stressful conditions. • Highly susceptible to bunchy top and nematodes. • Moderately susceptible to weevil borer.
Ladyfinger	Grows to 5.5m Produces 7 to 10 hands in bunches of 10 to 30 kg	<ul style="list-style-type: none"> • Less competition from tropical growers. • Higher prices. • Rarely requires propping. • More hardy in cold, windy and dry conditions. • Fruit does not turn black after slicing during food preparation. • Acid/sweet flavour. 	<ul style="list-style-type: none"> • Expanding area on the Atherton Tableland in North Queensland. • Highly susceptible to Panama disease. • Lower yields per hectare. • Flying foxes and birds are often a problem. • Requires regular treatment for flower thrips and caterpillar pests. • Requires regular deleafing to control <i>Deightoniella</i>. • Quality fruit important for best prices to be achieved.

The main characteristics of other varieties, some of which are grown commercially in a small way, are shown in Table 4.

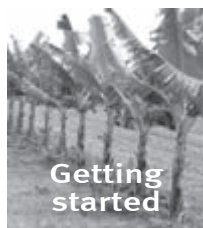


Varieties
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Table 4. Characteristics of other varieties

Variety	Growth and production	Comments
Bananza (formerly FHIA 18)	<ul style="list-style-type: none"> • Grows to 4.0 m • Similar appearance to Goldfinger • Considered to have a marginally better taste than Goldfinger by some consumers 	<ul style="list-style-type: none"> • Panama disease resistant. • Planting material only available under license. • Currently under commercial trial, growing recommendations still to be established. • Currently only limited release*.
Ducasse	<ul style="list-style-type: none"> • Grows to 5.5 m • Produces 9 to 12 hands in bunches of 25 to 35 kg 	<ul style="list-style-type: none"> • Fruit sold as whole hands. • Naturally ripened fruit is preferred by Asian market. • Niche market within the Asian community.
Dwarf Cavendish	<ul style="list-style-type: none"> • Grows to 2.0 m • Produces 8 to 12 hands in bunches of 25 to 50 kg 	<ul style="list-style-type: none"> • Very susceptible to ‘choke throat’. • Now superseded by Williams and Mons Mari. • Shorter fruit than Williams and Mons Mari.
Goldfinger	<ul style="list-style-type: none"> • Grows to 3.7 m • Produces 7 to 15 hands in bunches of 25 to 50 kg 	<ul style="list-style-type: none"> • No competition from tropical growers. • Resistant to leaf spot and Panama, but susceptible to speckle, nematodes and borers. • Fruit does not turn black after slicing during food preparation. • Long term market performance still being established, lower consumer acceptance. • Requires propping in the first year.
Grande Naine	<ul style="list-style-type: none"> • Grows to 3.0 m • Produces 7 to 14 hands in bunches of 25 to 60 kg 	<ul style="list-style-type: none"> • Similar to Giant Cavendish but shorter in height. • Useful in windy sites as alternative to Giant Cavendish. • Has not performed well in the Bundaberg area.
Pacific Plantain	<ul style="list-style-type: none"> • Grows to 4.0 m • Produces 10 to 15 hands in bunches of 25 to 40kg 	<ul style="list-style-type: none"> • Very susceptible to banana weevil borer. • Better suited to tropics. • Mainly used for cooking.
Red Dacca	<ul style="list-style-type: none"> • Dwarf variety grows to 2.5 to 3.5 m. Tall variety grows to 5.5 m • Produces 5 to 7 hands in bunches of 20 to 35 kg 	<ul style="list-style-type: none"> • Novelty variety because of red skin colour. • Low yields. • Fruit colour is not stable –can revert to green colour.

* The rights to Bananza in Australia are managed by the Australian Nurserymen’s Fruit Improvement Company/Breeders Rights International (ANFIC/BRI). For more information contact Rod Curly (BRI) 03 9775 3113.



Plant density

In the subtropics, Cavendish may be planted in double rows, whilst Ladyfinger and Goldfinger are all usually planted in single rows. The range of plant spacings and plant densities are shown in Table 5.

Table 5. Common plant spacings and densities

Variety	Spacing between plant (m)	Spacing between rows (m)	Plants per ha
Cavendish	1.8–2.1	3–3.5	1361–1852
Ladyfinger	3–4	3.2–4	625–1041
Goldfinger	2.5–3	3	1111–1333

High humidity promotes disease development. Consequently, in areas of high rainfall and high humidity, wider plant spacings are recommended. In dry areas with low humidity, plants can be grown closer together.

In dry areas without irrigation, wide spacings are needed to reduce competition for water. Where crops are grown under irrigation in dry climates, planting distances can be closer because the risk of disease spreading between plants is low.

Order the plants

Work out the number of plants needed and order them from one of the approved planting material sources at least **12 months prior to your expected planting date**. Clean planting material is essential. This reduces the risk of importing diseases and pests like banana bunchy top virus, Panama disease, banana weevil borer and nematodes. Clean planting material can be obtained by:

- using tissue cultured plantlets (Figure 10);
- producing your own bits and suckers from tissue cultured plantlets in a clean field nursery;
- only buying field-grown material from properties known to be free of these pests and diseases.

Tissue cultured planting material

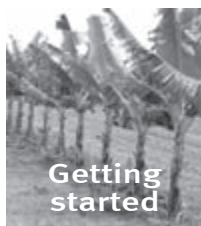
Tissue cultured plants require potting up and growing on in a nursery before transplanting into the field. This will enhance survival especially where irrigation is not available.

High humidity and warm temperatures are necessary in the early stages to establish tissue cultured plantlets in potting mix. Plants are transplanted into a 100 to 125 mm pot and grown to the 8 to 10 leaf stage. This is done in a QBAN nursery or on the farm if plants are intended for own use. Plants are



QBAN nurseries & planting permits
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Figure 10. A potted tissue cultured plantlet



finally hardened-off and transplanted into the field. Rogue out (remove and destroy) any off-types before planting in the field.

Always buy plants from QBAN nurseries as they must be registered by DPI Queensland and NSW Agriculture, and are required to meet stringent guidelines to maintain plant quality.

Vegetative planting material

Conventional vegetative planting material is not recommended because of the risk of bringing in pest and disease problems such as banana bunchy top virus (BBTV), weevil borer, nematodes, Panama disease (*Fusarium wilt*) and rust thrips. It is commonly used, however, because it is initially cheaper than tissue cultured material. Vegetative planting material consists of pieces of plant rhizomes (corms) – called bits, that carry mature eyes or buds, or small corms of advanced suckers (offshoot of parent plant) taken from approved plantations (see Figure 11). Use ‘sword’ leaf suckers which have better growth potential in preference to broad leaf suckers, and avoid ‘water’ suckers. Recommended size grade standards for this material are shown in Table 6.

A sucker, the most readily available planting material

Sucker, trimmed ready for planting

Bit, which is a section of a corm, trimmed to a single eye

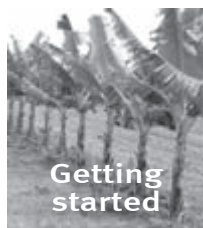


Sucker selection
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Figure 11. Other types of vegetative planting material

Table 6. Recommended vegetative planting material standards

Variety	Suckers	Bits
Cavendish types	75 mm dia	100 mm long x 75 mm x 75 mm
Ladyfinger	100 mm dia	125 mm long x 100 mm x 100 mm



Prepare field planting material

Select the preferred stage of plant growth for digging rhizomes (corms)—prior to or just after the bunch emergence stage when high carbohydrate reserves are present in the corm. Rhizomes (corms) from these plants should yield 12 to 15 bits.

Separate the bits—bit planting material should weigh between 0.5 and 1.5kg and be free of nematodes, banana weevil borer, rust thrips and all serious diseases. Each bit must have one prominent eye. Remove as much soil as possible with a medium pressure, high volume water hose taking care not to damage the eyes on the bits.

Dig the stools—in planting material nurseries, stools can be dug using a range of methods depending on the soil type, crowbar, mattock and shovel, back-hoe tractor, excavator or specially built ripper with twin shank cutter bars. In sandy loam soils, stools are easier to dig and wash than in heavy clay soils. Digging is easier in moist soil.

Separate suckers from the base (butt) of the mother plant—use sharp desuckering tools and sort by size. Small sword suckers can be removed before digging the stools.

Bits and suckers should be pared to remove all roots and excess leaf bases (Figure 12). Discard bits and suckers with signs of banana weevil borer or burrowing nematode damage on the corm. This will reduce, but not eliminate, the amount of infected soil and plant material that is moved to the planting site. Preparation of bits and suckers is very labour-intensive and specialist skills are needed; contractors can be employed to prepare bits and suckers if necessary. Alternatively, you may be able to buy bits and suckers.

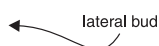
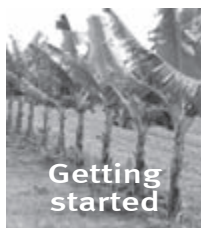


Figure 12. A pared banana bit; sometimes the leaf bases are cut away to check for the presence of a lateral bud or eye



more info



Windbreak & native
vegetation
Chapter 5 page 183

More information on trees suitable for windbreak use and their care is available in the following publications: *Trees for NSW North Coast* and the *Tree and Shrubs* (3rd Edition) and from Landcare groups. See Chapter 5, pages 183 and 186 for details on where to buy these books.

Plant windbreak trees to supplement standing timber

Wherever possible, leave stands of natural timber to act as windbreaks for the plantation. Larger more competitive main windbreak species (see Table 7) can be used where there is enough room to leave a 10 m gap between the trees and the first row of bananas (Figure 13). If space around the perimeter of the block is limited, use low storey species that are not as competitive. Plant low storey windbreak trees at least 6 m from the plantation edge to allow machinery access and to reduce competition for water and nutrients.

Table 7. Windbreak species suitable for subtropical areas in Queensland

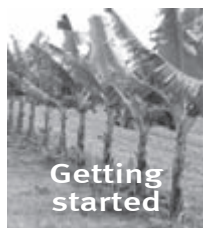
Scientific name	Common name
Main windbreak	
<i>Allocasuarina littoralis</i>	Black sheoak
<i>Allocasuarina torulosa</i>	Rose sheok
<i>Callitris columellaris</i> var. <i>columellaris</i>	Coast cypress pine*
<i>Casuarina cunninghamiana</i>	River sheoak*
<i>Casuarina glauca</i>	Swamp sheoak*
<i>Melaleuca bracteata</i>	River tea-tree*
<i>Melaleuca leucadendra</i>	Broad-leaved tea-tree*
<i>Melaleuca quinquenervia</i>	Broad-leaved tea-tree*
<i>Melaleuca styphelioides</i>	Prickly tea-tree*
<i>Pittosporum undulatum</i>	Mock orange*
<i>Syzygium australe</i>	Creek satinash*
<i>Syzygium luehmannii</i>	Cherry satinash*
<i>Waterhousea floribunda</i>	Weeping satinash*
Low storey	
<i>Acacia floribunda</i>	Catkin acacia
<i>Acacia salicina</i>	Cooba
<i>Acacia saligna</i>	Golden wreath wattle
<i>Banksia ericifolia</i>	Heath-leaved honeysuckle
<i>Callistemon salignus</i>	White bottlebrush*
<i>Callistemon viminalis</i>	Weeping bottlebrush*
<i>Hakea salicifolia</i>	Willow-leaved hakea*
<i>Leptospermum petersonii</i>	Lemon-scented tea-tree
<i>Tristaniopsis laurina</i>	Kanuka box

* Indicates these species can be planted as single row windbreaks, other species need to be planted in multiple rows



Figure 13. An established planted windbreak

When planting windbreak trees, first deep rip rows to at least 60 cm before planting. If ripping downhill, lift the toolbar every 30 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 mixed tree fertiliser will promote rapid growth. Maintain a weed free area around the trees. Irrigation of the trees, if possible, will give quicker growth of the windbreak and maximise protection of the bananas.



Nutrition
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Do a soil analysis and apply required fertilisers

Get a soil analysis done to check the nutrient status of your soil. Soil sampling kits are available from your local farm supply store. Follow the sampling instructions and send the sample away for analysis. Results should be back in about two weeks and will be interpreted by a representative of the laboratory analysing your sample. Samples should be analysed at least six months prior to planting. Discuss your results with your local farm supply agent and work out what fertilisers are required.

Prior to planting is the best time to apply less soluble fertilisers such as lime, dolomite, gypsum, superphosphate, copper and zinc. These fertilisers should be well incorporated throughout the intended root zone before planting.

Grow a green manure crop

Establish a cover crop or green manure crop in the crop site as soon as possible. This helps to prevent soil erosion, improves soil structure by adding organic matter, and can be used to reduce nematode levels in replant situations.

Where the site has been newly cleared, you can plant a short-term manure crop such as Brassica cv. Hyola 42 or mustard at 10 to 15 kg/ha plus for autumn plantings and Rhodes grass cv. Callide at 5-10 kg/ha for spring or summer plantings.

In cases where bananas have been eradicated and the site is to be fallowed before another banana crop, use a long-term manure crop like Rhodes grass cv. Callide, planted in the spring or summer, at 5 to 10 kg/ha. Grow for as long as possible, at least 1 to 2 years, before replanting to bananas.

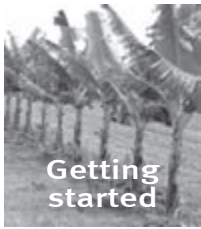
HINT

In NSW further advice on cover crops can be obtained from NSW Agriculture or the DLWC

If fertiliser was not applied as recommended above, apply 250 kg/ha of molybdenum superphosphate before planting the green manure crop. Double this quantity in red volcanic soils.

After the crop emerges, apply 100 kg/ha urea. On poorer, sandy soils, more fertiliser and more frequent applications may be necessary.

Using a herbicide such as glyphosate, spray out the green manure crop in strips where the bananas will be planted. Do this two to three weeks before planting the bananas.



Mark out the rows

Rows across the slope are marked on the contour, parallel to the top diversion bank or access tracks or a surveyed key line. If using a key line, wire is tightly stretched between two people at right angles to the key line and points marked every 20 metres along the row (Figure 14). Rows up and down the slope are usually marked either at right angles to the contour or parallel to the longest row. Strip-spray a herbicide along the rows prior to planting the bananas.

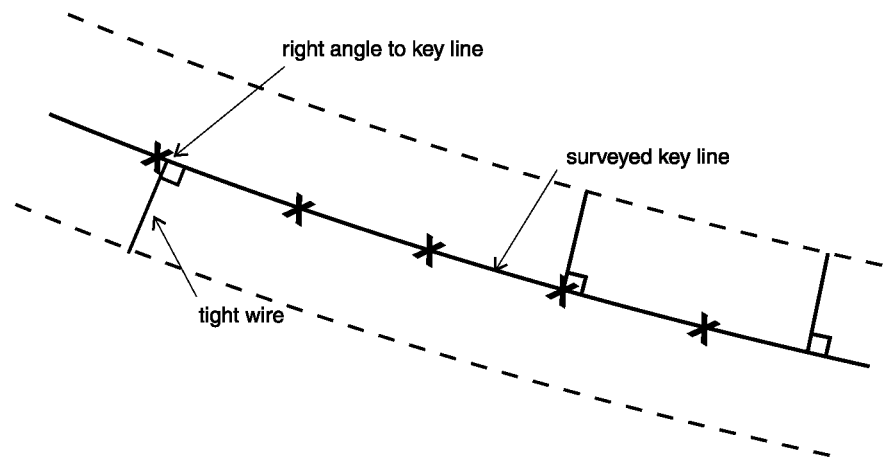


Figure 14. Marking out parallel rows across the slope

Install the irrigation system

If necessary, install the system on the basis of an irrigation design plan prepared by a qualified irrigation designer. This will ensure that you have the irrigation capacity to meet the needs of your plantation. Minisprinklers are recommended. Use sprinklers with an output of 80 to 150 L/hour.

Plant

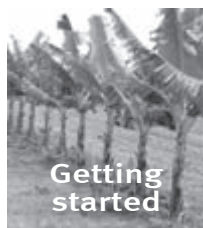
Tissue cultured planting material is recommended, since it is disease and pest free. Check that the plants have been sun-hardened before planting out; if not then ensure that pots are watered regularly while they are hardened-off. The water requirement (both quantity and frequency) for tissue-culture plantlets is greater than for bits and suckers.

Tissue cultured plants need to be well watered at planting and until they establish. It may also be necessary to use temporary sunscreens such as shadecloth for the new plants. However, this is an expensive option and

a key issue



Irrigation
Chapter 4 page 121



Types of suckers
Chapter 4 page 99

is not normally needed if plants have been properly sun hardened. Avoid planting during very hot dry conditions.

Suckers and bits that are ready for planting must be stored in a cool, shaded, dry place. Do not leave planting material in air-tight bags for extended periods as they will rot. Fertiliser bags without plastic liners are quite satisfactory for storing bits and suckers for several weeks provided that material has been correctly cured or air-dried. Plant as soon as practicable. Stage the supply of material to suit your planting schedule.

Size grade all suckers and bits and plant similar size together so providing a more even growth of plants in each area.

Prepare individual planting sites by hand with a mattock or use a single tynes ripper. Avoid posthole diggers that can compact the sides of the planting hole often causing rotting of the planting material. Bits should be planted with the eye 150 to 230 mm below ground level, depending on soil type. In the heavier clay loam soils, a depth of 150 mm is required, with 190 mm in loam and 230 mm in sandy loams. On sloping sites, the eye is placed in the uphill position so that growth will be deep rooted in the soil (Figure 15).

Suckers should be similarly planted with the widest section being 150 to 230 mm below ground level.

If the soil is sufficiently moist at planting, further irrigation should not be necessary until after shoot emergence. Otherwise, water plants well after planting. Avoid over-watering as it may cause plants to rot.

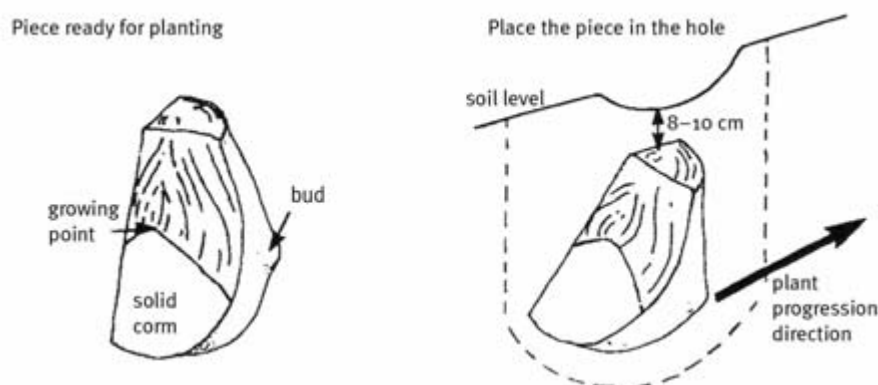


Figure 15. Planting bits (pieces) on slopes



Managing the crop

Once plants are established, the aim is then to optimise the growth of the plants and protect that growth against pests, diseases and other problems. This involves the following 10 steps:

- Fertilising
- Irrigation
- Weed control
- Trash management
- Desuckering and sucker selection
- Managing pests and diseases
- Bunch covering, trimming and debelling
- Bunch support
- Eradication of disease and unwanted plants
- Windbreaks

Fertilising

Bananas are a high yielding and rapidly growing crop requiring large amounts of fertiliser to maintain productivity. The main requirement is for potassium (K) and nitrogen (N). Other key nutrients for bananas are calcium, magnesium, zinc and boron. Low calcium levels are thought to be associated with maturity bronzing of fruit and other physiological disorders. Calcium and boron deficiencies are often associated with very dry or very wet seasonal conditions.

Leaf and soil analyses

Fertiliser needs should be determined by using soil and leaf analyses, which should be done once a year. This will allow you to determine how effective your fertiliser application program has been and what changes might be necessary.

Soil and leaf sampling kits are available from your local farm supply store. Follow the sampling instructions and send the samples away for analysis. Results should be back in about two weeks and will be interpreted by a representative of the laboratory analysing your sample.



Nutrition
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Some kits are packaged as 'triple check' kits allowing a leaf analysis and two soil analyses from different depths (0 to 10 cm and 10 to 20 cm). Use these where possible as they provide a better representation of nutrient requirements. Sample four to six weeks after the last fertiliser has been washed in by rain or irrigation. Sample the third last, fully expanded leaf of un-bunched plants, sampling strips of lamina 20 cm wide from each side of the mid-rib in the mid-section of the leaf (Figure 16).

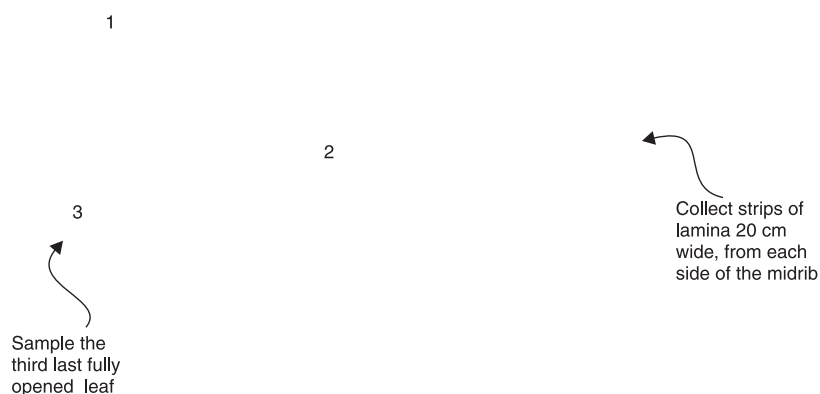


Figure 16. Sampling bananas for leaf analysis

Sampling can be done in summer, autumn or spring, whichever is most convenient as long as the plants are growing well. It is essential that leaf sampling is done at the same time each year to ensure that differences in results between years reflect changes in nutrient status and are not due to the seasonal growth of the plant.

Fertiliser strategy

Demand for nutrients increases in the plant crop as the plants approach bunching, and the ratoon (following) crop suckers are being set. Remove excess suckers to reduce competition. After bunch harvest, cut off pseudostems at a height of 1.5 m to 2 m, retaining the old pseudostems to provide nutrients to the ratoon suckers.

If lack of water is the major limitation to growth then growth cannot be improved by the addition of more fertiliser.

Since there is minimal growth in the May to August period, there is little response to nitrogen and potassium fertiliser applied during this period. However lime or dolomite applications should be applied in this period so that adequate supplies of these nutrients are available for spring growth. Broadcast the lime or dolomite over the entire interrow area.



Managing the crop

Frequency and timing of fertiliser application

Apply nitrogen, which is readily leached from the soil, up to 10 times a year in an irrigated plantation or more if you fertigate. In a non-irrigated plantation 6 to 10 applications a year, depending on seasonal conditions, will be adequate. Nitrogen should be applied in each month (except winter) if there has been adequate rain (about 25–50 mm) since the last application. Where irrigation is available, fertigation can be the most efficient way of applying many nutrients. Do not apply too much water during fertigation since nutrients can be washed down the soil profile and out of the root zone, making them unavailable to the plant.

Apply potassium three times a year, unless mixed with nitrogen or in fertigation, when more frequent applications can easily be made.

Phosphorus, calcium (lime), and magnesium need only be applied once a year when convenient.

Mixes containing nitrogen should be used little and often. The preferred forms of nitrogen fertiliser are calcium nitrate, ammonium nitrate or potassium nitrate. It is essential to irrigate after application of urea because it can volatilise into the atmosphere in hot dry weather.

Table 8 shows the suggested times for fertiliser application.

Broadcast fertiliser evenly over the entire inter-row area (Figure 17). Wait four to six weeks since the last fertiliser application before taking soil and leaf samples.



Figure 17. Fertiliser should be spread across the entire interrow

Table 8. Suggested timetable for fertiliser application

Month	Fertiliser to apply
January	<ul style="list-style-type: none"> • Nitrogen * • Potassium if not in a mix with nitrogen
February	<ul style="list-style-type: none"> • Nitrogen *
March	<ul style="list-style-type: none"> • Nitrogen * • Potassium if not in a mix with nitrogen
April	<ul style="list-style-type: none"> • Nitrogen * • Wait 4–6 weeks since last fertiliser application then take soil and leaf samples
May	<ul style="list-style-type: none"> • Order lime and fertilisers on basis of test results
June	<ul style="list-style-type: none"> • Lime and magnesium product as indicated by tests • Superphosphate
July	<ul style="list-style-type: none"> • Normally too cold for fertiliser application to be beneficial but complete June program
August	<ul style="list-style-type: none"> • Normally too cold for fertiliser application to be beneficial
September	<ul style="list-style-type: none"> • Nitrogen* • Potassium if not in a mix with nitrogen
October	<ul style="list-style-type: none"> • Nitrogen *
November	<ul style="list-style-type: none"> • Nitrogen*
December	<ul style="list-style-type: none"> • Nitrogen*

* For non-irrigated plantations, divide nitrogen requirements into 6 applications per year applied on a regular basis, to coincide if possible with rainfall periods.



Managing the crop



Monitoring methods
Chapter 4, page 122

Irrigation

It is recommended that irrigation is scheduled using tensiometers or other monitoring methods. Get expert advice from irrigation specialists on how to locate and install tensiometers. Select a position that is representative of the plantation and position two tensiometers, one with its tip at a depth of 20 cm and the other with its tip at a depth of 50 cm. Start watering when the shallow tensiometer reads 20 centibars in sandy loam soils or 30 centibars in clay loam soils. Stop watering when the deep tensiometer reads 10 centibars.

In northern New South Wales, irrigation requirements for bananas are published weekly in the local press.

If tensiometers are not being used, a rough guide to plant water needs is from 50 L/stool/week at establishment to 200 L/stool/week at bunching. These amounts should be applied in one or two waterings per week.

Weed control

Weeds compete for fertiliser, water and light, harbour pests and rodents and make it more difficult to detect pests and diseases. In Queensland, it is a legal obligation to keep vegetation within a 2 m radius of bananas, to less than 60 cm high (30 cm in NSW) to facilitate inspection by plant health inspectors. Weed control is critical in plant crops whereas ratoon crops tend to shade out most weeds. The main method of weed control is use of herbicides but it is recommended that this be combined with mulching and ground covers where possible. Mechanical weed control by cultivation or chipping is generally not recommended on the steeper slopes because of erosion and root damage.

Chemical weed control involves spraying using hydraulic nozzles of the flat fan or flood jet type or controlled droplet applicators (CDA). The hydraulic nozzles are most suitable for contact type herbicides while the CDA applicators offer some advantages for systemic herbicides. It is important to identify the swath of spinning disc type CDA sprayers to avoid contact with banana suckers and stems, particularly for herbicides such as glyphosate. Care needs to be taken to ensure correct application rates by calibrating spray jets to achieve the desired result and to minimise chemical costs.

Weed control strategy

First year

Strip spray around each plant and along the row with either glyphosate or glufosinate-ammonium (Basta). Glufosinate-ammonium is preferred since any accidental spray drift onto the banana will cause less damage



Managing the crop

than glyphosate. Angle the nozzle away from the banana plants at all times and avoid any contact of the herbicide with the pseudostem. Grasses that are so close to the banana stems that they cannot be sprayed safely, should be removed by hand.

Second and subsequent years

Spot spray with either glyphosate, glufosinate-ammonium (Basta), or a mixture of paraquat and diuron. Spray weeds to the point of runoff (sufficiently wet to just run off leaf surface to ensure adequate coverage without waste). Alternating the three options helps to prevent the build-up of weeds resistant to one chemical. For example, if wandering jew weed increases under a glyphosate program, the Basta or paraquat/diuron alternatives generally provide reasonable control. Again, avoid any contact of the herbicide with the pseudostem.

Application methods

Herbicides are often applied using either low volume knapsacks, or tractor-drawn pump units fitted with a handgun or lance. In the case of systemic herbicides like glyphosate, either wick applicators or CDA sprayers can be used.

Chemical application and safety

Spray equipment must be well maintained and calibrated regularly to ensure the correct amount of chemical is applied. Operators should have a full understanding of the equipment and the principles of spray application to maximise efficiency and minimise spray drift.

Before using any chemical, always read the label and follow its directions. Observe full safety precautions including the use of safety equipment and protective clothing. In NSW every application of pesticide must be recorded. It is strongly recommended that all growers attend an approved Chemical Users Course.

a key issue



Pesticide application
and safety
Chapter 4 page 130

more info



Chemical & spraying
information
Chapter 5 page 184

Trash management

Regular, routine removal or detashing of dead leaf is done to encourage growth and vigour of the plant and reduce the incidence of leaf and fruit diseases. Dead leaves harbour fungal spores which spread leaf spot and speckle and leaf trash reduces the penetration of sunlight and heat to the corm. This further slows the growth of the sucker, thereby delaying bunching.

Banana trash on the soil surface helps reduce erosion by protection from raindrop impact and slowing rainwater runoff. It also helps to control weeds and improves moisture retention. Breakdown of leaf litter improves soil condition and fertility.

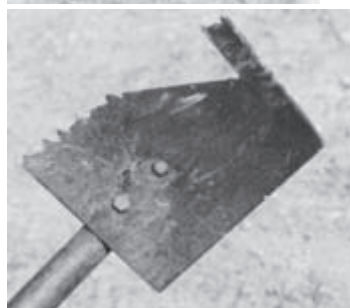


Figure 18. Various tools suitable for deleafing

Remove only dead leaves and leaves with more than 30% of the leaf affected by disease. Old leaves that are still green and without disease are still functional and removal of these leaves, particularly in winter, can stress the plant.

Cut the leaf with a sharp cane knife on a long handle or a reaping hook on a similar handle (Figure 18). Detrash on a regular basis—a monthly routine is recommended; it is easier to cut leaves that are still alive and turgid than ones which are completely dead. Care must be taken to avoid cutting into the pseudostem. Note that unless butt sprays of chemicals are being used for banana weevil borer control, it is not essential to keep the trash away from the base of the plants, however where this is done it has the advantage of making egg laying less attractive and more difficult. Trash is beneficial in improving root health and growth.

Desuckering

Desuckering is the practice of removing unwanted suckers from the mother plant leaving the sucker that you wish to become the next cropping plant. Sucker selection can reduce problems associated with bunches which fill in winter, helps control the crop cycle and maintain plant densities.

Desuckering in a plant crop

The straight-through follower system is recommended, where a single sucker is selected on the uphill side and subsequently another sucker is selected on the uphill side of the first sucker.

- Select the first deep sucker on the uphill side of the parent plant, or along the row, and allow it to develop. This sucker normally appears about 13 cm from the base of the parent on the uphill side about 6 months after planting. It should have a broad base, be spear-shaped and produce narrow 'sword' shaped leaves until it is about half the height of the parent.
- Remove all other suckers at frequent intervals.

Desuckering in a ratoon crop

Two different methods are used to select a sucker.

1. Remove all suckers until the parent plant is about to bunch, and then select the next sucker on the uphill side of the parent or along the row. This method allows you to manipulate the time of harvest to coincide with better prices.
2. Select the first suitable sucker that appears on the uphill side of the parent or along the row. This method ensures production of ratoon bunches at the shortest interval and may reduce time of harvest of the ratoon bunch to less than twelve months after the plant crop. In



Selection of following sucker
Chapter 4 page 98



favourable climatic, nutritional and soil moisture conditions, up to two bunches per year can be produced.

Sucker removal (desuckering)

Routine and regular desuckering of excess suckers every four months or more frequently is essential to remove unnecessary growth and competition from the plantation.

One of two methods may be used on plant or ratoon crops.

1. Cut unwanted suckers off at ground level. Immediately gouge out the centre and pour in about 2 to 3 mL of kerosene or distillate. A faster, more convenient method is to inject the same amount into the growing point of the corm using a Velpar spot gun and lance or a Sidewinder injection gun (Figure 19). The growing point is located in the centre, at the junction where the compacted leaves (pseudostem) join the rhizome (corm).
2. Use a gouging tool (a bar or desuckering shovel) to destroy the sucker (Figure 20). This can reduce the stability resulting in plants falling over in strong winds.

more info



Equipment manufacturers
and suppliers
Chapter 5 page 183



Figure 19. Injection technique using a Sidewinder. Note that in this demonstration, safety gear is not used



Figure 20. Gouging tools used for desuckering (left); close-up of desuckering tool in use

Managing pests and diseases

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, preferably using an Integrated Pest Management (IPM) approach and timely spray applications.



Managing the crop

Pests

The major pests of all varieties in southern Queensland are banana weevil borer, spider mites, thrips and nematodes. In Ladyfinger bananas, flower thrips and sugarcane bud moth are major pests.

In NSW, banana weevil borer, sugarcane bud moth, rust thrips, nematodes and in the southern areas spider mites are important pests in Cavendish. In Ladyfinger, flower thrips is also significant.

A number of control methods have been developed for banana pests. Table 9 indicates the suitability of each of these methods for control of these pests.

Table 9. Methods for control of subtropical insect pests of bananas

Method	Flower thrips	Rust thrips	Sugarcane bud moth	Mites	Banana weevil borer
Bell injection	very effective	very effective ¹	effective	nil	nil
Bunch spray	effective ²	very effective	effective	partly effective	nil
Bunch dusting	partly effective	very effective	very effective ³	nil	nil
Cover sprays	not effective	partly effective	unknown	adverse ⁴	nil
Aerial sprays	not effective	partly effective	unknown	adverse ⁴	nil
Pseudostem injection	nil	nil	nil	nil	effective
Butt spray	nil	partly effective	nil	nil	partly effective

Bell injection followed by another bunch spray after bract fall is normally very effective.



Bell injection
Chapter 4 page 138

¹ Bunch injection is only effective against rust thrips at the time of bunch emergence and further treatment is required for protection during fruit development.

² Regular spraying of the emerging bunch is required.

³ Requires a follow up treatment at time of bunch covering to give longer protection.

⁴ These treatments reduce the effect of beneficial predators resulting in mite increase.

Bird and animal pests

Nectar feeding birds, flying foxes (fruit bats) and other animals such as sugar gliders may cause considerable damage to fruit. Sometimes relatively small marks on green fruit can develop into an unsightly blemish on the ripe fruit. Apply bunch covers as early as possible to the developing bunches and ensure that there is no ripe fruit hanging in the plantation which will attract birds and flying foxes.

Many native birds and animals are protected species, requiring special permits from the National Parks and Wildlife Service for control. Feral animals such as pigs also cause damage and contribute to the spread of Panama disease. For more information, contact the Environmental Protection Agency in Queensland and The Rural Lands Protection Board in New South Wales.



Photos and what to do about the problem can be found in the companion book, *PICTURE GUIDE: Subtropical Banana Problem Solver*

Photos and more detail on each disease are found in *Diseases of Fruit Crops* available from DPI Queensland offices.

Diseases

The major diseases affecting bananas in south Queensland and NSW are banana bunchy top virus (BBTV), Panama disease, leaf speckle and leaf spot (also called yellow Sigatoka). Sooty blotch, sooty mould and *Deightoniella* are common problems on Ladyfinger fruit. A number of minor diseases and physiological disorders also occasionally affect bananas. Several postharvest diseases such as anthracnose, crown rot, squirter and cigar end may also cause substantial losses.

Observe strict quarantine measures regarding movement of banana plants. Before moving or planting bananas, contact DPI Queensland to obtain the necessary plant health certificate or NSW Agriculture for a permit.

Banana bunchy top virus control

Regular inspections are necessary to detect bunchy top in the early stages. Since this virus disease is spread from plant to plant by the banana aphid, it is essential to locate and destroy diseased plants before infection can spread. Control involves killing all aphids on the plant and eradication of the infected plant including attached suckers.

Note that banana aphids are commonly present on most plants and generally cause few problems. Their presence on a plant does not mean that it is infected with bunchy top. It is only those that have fed on an infected plant that will be carrying the virus. Therefore it is essential to identify infected plants early and kill the aphids present before they fly off to infect other plants. The destruction of the plant then prevents any further risk of aphid feeding and virus spread.

In Queensland. Spray the plant with pure kerosene or a mineral oil, particularly down the throat of the plant, to kill aphids. Then dig out and chop up the infected stool so that it will not regrow, or inject with 2,4-D amine or glyphosate. All regrowth must be destroyed.

It is the grower's responsibility to locate and immediately eradicate infected plants. Growers must report the detection of any BBTV infected plants to the DPI plant health inspector within 24 hours. Where an infected plant is detected, a number of adjacent banana plants, within a radius of up to 20 m may have to be destroyed, as directed by the inspector.

In NSW. Inject the plant with glyphosate to kill the plant, followed immediately by an injection of dimethoate to kill any banana aphids which may spread the disease from the dying plant to other plants.

In Queensland and NSW. Planting material can only be taken from plantations at least one kilometre away from any BBTV infected site. A permit is required.



Managing the crop

Panama disease control

Since the disease is spread in infected planting material, infested soil and drainage water, great care needs to be taken. Using tissue cultured planting material is the best way of ensuring that Panama is not spread into disease free sites. Site selection to avoid replanting infested soils and good hygiene to reduce the movement of the fungus into disease free patches should also be practised. Where infected plants are found, inject them with a herbicide and leave standing. Do not dig out infected plants as this is likely to spread the fungus.

Avoid moving soil between farms, for example by vehicle tyres, shared machinery, implements and on footwear. Contact plant health inspectors any time you are moving equipment—they can offer information for decontamination procedures to clean machinery. Drainage water can also carry the disease from an infected site to an uninfected area. Restrict vehicle access to the property where practical. Place large quarantine entry signs at property entrances.

In Queensland. Planting material cannot be taken from an infected site or anywhere within a one kilometre radius of an infected site, except where permission has been granted by the plant health inspector for an existing Ladyfinger grower proposing to replace or extend a plantation that is already infected using plants from that same plantation.

In NSW. Planting material can only be taken from plantations at least 500 m from any known Panama infected site.

Leaf disease control

Leaf diseases prematurely defoliate the plant. This affects fruit size and quality and can lead to problems with mixed ripe condition or premature ripening. Regular deleafing together with a routine spray program is recommended. Ladyfinger and Goldfinger are more resistant to some leaf diseases than Cavendish.

In NSW. A leaf disease monitoring system is available to better schedule the spray program. Infection periods are identified weekly using special weather stations and infection points calculated. These are published weekly in local newspapers and broadcast on local radio. Spraying is recommended where 250 points accumulate since the last spray was applied. However, there is generally no need to spray more regularly than every three weeks.

Nematode control

The use of tissue cultured planting material is the only sure way to avoid the spread of nematodes to clean ground. Other management strategies involve using QBAN approved planting material sources, planting on clean ground, eradicating neglected and feral bananas and the use of nematicides to reduce damage.



Controlling leaf spot
Chapter 4 page 156

Chemicals registered for control of leaf diseases are given in Chapter 6, *Chemical Handy Guide*



Nematode reduction strategies
Chapter 4 page 149



Bunch trimming, debelling, bunch covering, support

Bunch trimming

Bunch trimming is done to remove smaller fruit from the bottom of the bunch. The practice helps maximise the production of larger fruit that generally receive higher prices. Bunch trimming also speeds up the filling of the fruit and is essential in the cooler subtropical areas where low temperatures restrict the capacity of the plant to fill all fruit on the bunch adequately during winter.

The amount of trimming varies from half of the last hand of winter-emerged bunches trimmed during September/October, to half the bunch of autumn-emerged bunches (5 to 6 hands for Ladyfingers and 7 to 8 hands for Cavendish). Bunches are best trimmed as soon as the flower bracts lift to reveal the bottom hand (Figure 21). It is usual practice to leave a couple of fruit on the lowest hand to avoid rotting back of the bunch stalk. Severe trimming requires a compromise between enhanced fruit size and lower bunch weight. Bunch trimming can be used to promote quicker filling of fruit and reduce the incidence of dull fruit, which can be a problem if fruit mature during the cooler winter months.



Figure 21. Removal of smaller hands and the bell during bunch trimming



Figure 22. Early debelling of Ladyfinger bunches helps reduce flying fox and bird damage

Debelling

This is commonly done to increase bunch weight and to remove feeding sites for pests and insects. The bell is removed to within 100 mm of the lowest hand of fruit after the last hand has set. Bells can be conveniently removed when bunch trimming is done. Ladyfinger bells (Figure 22) produce large amounts of nectar and attract flying foxes and birds. It is therefore best to remove them as early as possible where these pests are prevalent.

Bunch covering

Bunch covering is essential, with greatest benefits during winter. Bunch covers are used to:

- reduce fruit blemish by protecting the fruit against cold, wind, birds, flying foxes and insects;
- increase temperatures inside the bunch cover to improve the development of the fruit. It is important to use the right type of bunch cover in winter to maximise temperature under the cover, lighter coloured covers are best—pale green or yellow;
- increase bunch weight by up to 25%, and mature bunches up to two weeks earlier when combined with debelling;



Managing the crop

- retain protective insecticide applications;
- minimise mechanical damage in the field, during harvest and transport to the packing shed.

Protect fruit from bird and flying fox damage. Covers are normally applied as soon as the first flower bract has lifted. This is especially important for Ladyfinger and Goldfinger varieties. Where birds and flying foxes are severe problems, the fruit will probably have already been damaged if covers are applied after the last bract has lifted when bunch trimming is done. This may mean a round of bunch covering every week or fortnight. Where the problem is less serious, a round every three to four weeks is usually sufficient.

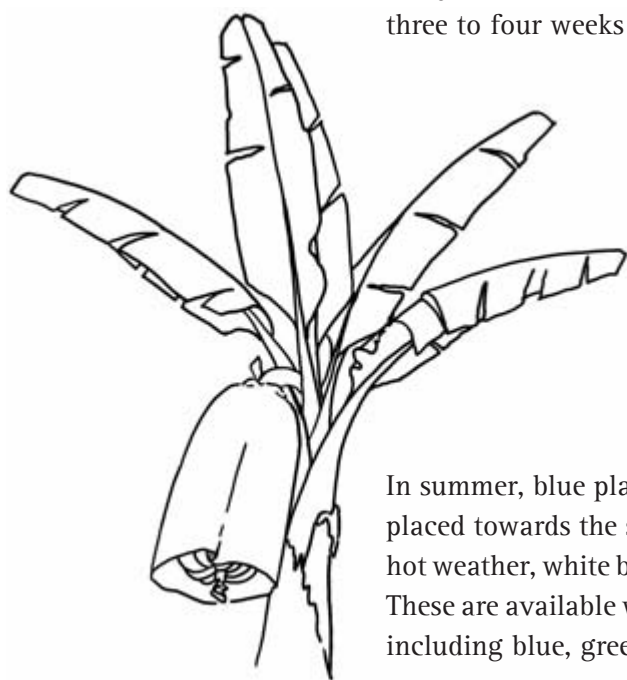


Figure 23. A correctly bagged bunch

Secure the covers. With most bananas, covers are secured at the top of the bunch only, a short distance up the bunch stem to hold the cover away from the top hand (Figure 23). This prevents water pooling on the top of the hand. During the hotter months, leave a gap big enough for two fingers between the bag and the stem to allow hot air to escape. During cold months, the covers are secured tightly for insulation.

In summer, blue plastic covers are commonly used with the silver side placed towards the sun. However, as some fruit burn can occur during hot weather, white bunch covers are preferred during the hotter months. These are available with a white exterior and a range of internal colours including blue, green and yellow.

Colour code or mark the covers. As it is difficult to see when covered bunches are ready to harvest, use the different coloured bunch covers for different bunching cycles. By colour coding bunch emergence, harvesting can be more easily managed. Alternatively, mark the cover in some way—staple coloured ribbons to the bottom of the cover; or mark the plant stems or engrave with the date the bunch was covered.

In winter a clear, silver-sided cover is often used on close-planted Ladyfinger bananas to promote quicker fruit filling. This cover should not be used on Cavendish, wide-spaced Ladyfinger or Ladyfingers in summer—overheating will damage the fruit. Ladyfinger covers are usually cut 900 to 1200 mm long, while Cavendish covers are usually 1200 to 1800 mm long.

Many Ladyfinger growers find that a two-stage bagging program prevents flying fox and bird damage on developing fruit. An extra long bag (double length or approximately 2 m long) is used to cover the developing bunch and bell as soon the bracts have opened, making it



Figure 24. Rubber band bunch applicator; bands are attached to the belt and bags on a sling



difficult for flying foxes or birds to reach the bell. Any bracts that fall off before the bag is removed simply fall through the bag to the ground. When the bell has been removed, the bunch is no longer as attractive to birds and flying foxes so the long bag can be replaced with a shorter bag.

Some Ladyfinger growers apply only the shorter bag and use staples to secure the bottom to avoid wind blowing the cover up and to prevent access by birds and flying foxes. The staples must be removed when debelling. Bracts that fall off before the staples are removed can rot in the bottom of the bag marking the lower hands.

Cavendish flowers are not as attractive to birds and flying foxes, so one bag of an appropriate length is applied to the bunch. Bunches mature about three to seven months after covering, depending on temperature and growing conditions.

Ladyfinger bananas are very susceptible to sunburn damage during the very hot summer months. Damage can be reduced using extra thick Ladyfinger covers or placing paper or hessian under regular thickness covers to protect the top hand of fruit on the bunch. Maintaining good leaf cover by fertilising and watering correctly protects fruit from sunburn. Sunburn is most common in the plant crop because of the minimal leaf cover, it is usually less serious in ratoon crops as leaf shade is greater.

A long handled Ladyfinger banana covering tool is often used to apply the bunch cover—two different designs are popular. One type type uses a trigger device to apply a large rubber band (Figure 24). Another design consists of a hoop-shaped frame which attaches covers by use of baling twine (Figure 25).

Cherry pickers can be used on larger properties with suitable terrain to make bagging easier and mechanise other operations such as bunch spraying or dusting (Figure 26).

Figure 25. Sequence of four photos showing the use of a hoop frame bunch cover applicator. The bailer twine roll is held in a container on the grower's belt



Figure 26. Cherry picker used for bunch covering



Bunch support

Support may be required to prevent the bunched plant from toppling during wet and/or windy conditions. Cavendish varieties (Mons Mari and Williams) will require propping or tying. Goldfinger usually requires propping or tying in the plant crop but not the ratoon crop. Ladyfinger seldom requires propping and Dwarf Cavendish occasionally requires propping. Props or ties should be applied as soon as possible after bunches appear at the top of plants.

Plants are either propped using one or two timber props, or tied to the base of the next uphill plant using baling twine. Twine ties are more common because of cost savings, but can restrict movement through the plantation. Props usually consist of a wooden pole fitted with a four to six cm long wire spike on one end. If tying, two lengths of baling twine are tied from the bunch stalk to the base of the two uphill plants (Figure 27). Black or orange polypropylene twine is used. The black twine is more expensive but it can be reused often due to its greater UV light resistance. The orange twine is easier to see in the plantation.

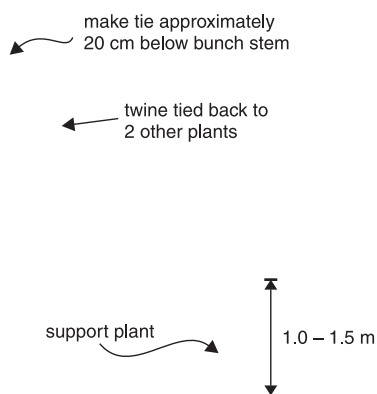


Figure 27. Positioning of string and a suggested tying pattern for plants

Eradication of diseased and unwanted plants

Neglected and feral bananas harbour pests and diseases and should be destroyed. The fact that the crop is sometimes grown on steep slopes makes track rolling (the rolling and squashing of plants) difficult, if not impossible. Even on flat ground, track rolling often results in breaking of stems with subsequent considerable regrowth.

Chemical eradication

A more effective method is chemical eradication. This method involves injecting each stem (including attached suckers) with a suitable herbicide such as 2,4-D amine (at 16 mL/L of water) or glyphosate (at 10 to 30mL/L of water). Use 5 to 20 mL of the solution depending on plant size.

Use extreme care when injecting small plants to ensure that the injector does not go right through the stem. Wear a facemask to avoid chemical 'spray back'. Drip herbicide down the candle leaf (the central unfurled leaf) of very small suckers.



Harvesting and marketing

The profitability of banana production depends on a strong commitment to marketing quality fruit. Only attractively presented, blemish-free fruit with a reputation for shelf life and flavour will achieve premium prices. Care when harvesting and with postharvest handling will ensure that your efforts in producing good quality fruit are not wasted. By

following these steps you will get fruit to the consumer in good condition. Pay particular attention to these important operations:

- Harvesting and dehanding
- Post-harvest treatment
- Grading and packing
- Transport and storage
- Marketing

Harvesting and dehanding

Assessing bunch maturity

Bananas are harvested in a mature green condition. The fruit should be fully formed and well filled, but with some of the angular appearance still visible. Because fullness of the fingers is influenced by many factors (such as moisture stress, temperature and nutrition) a combination of fruit age and fullness should be used as a guide for harvesting. Many growers use different coloured bunch covers or markings such as coloured tape or paint as a code to indicate when the bunch was thrown and consequently when it may be ready for harvest. As a general rule, it is best to harvest remaining bunches within a colour code once three quarters of the bunches in that code have been harvested. Mature green fruit is then ripened for sale, generally by wholesalers or merchants.

Harvesting

Harvesting is best done by teams of two people—one person cuts and the other carries. Banana bunches are harvested by nicking the pseudostem at about head height to allow the bunch to fall slowly to the carrier's shoulder. Taller varieties such as Ladyfinger are best nicked higher up the stem than shorter varieties. The bunch is then cut from the plant and



Figure 28. Washing bananas— by hand (upper); water spray over bananas on a packing wheel (lower)

Chemicals registered for the control of postharvest disease control are given in Chapter 6, *Chemical Handy Guide*.

carried to a transporter vehicle. A shoulder pad improves worker comfort and reduces bunch bruising. After the bunch is harvested, cut the pseudostem down to a height of about 1.5 to 2 m.

Bunches are transported to the packing shed in a padded trailer or 4WD vehicle's tray. Make sure that there are thick foam pads both between the bunch and other bunches and also between the bunch and the frame, sides and bottom of the trailer. A trailer or vehicle fitted with an A-frame is best because they are easy to load and bunches can be stood upright preventing damage. Keep harvested bunches out of the sun and as cool as possible. When fruit arrive at the packing shed, unload and store bunches on a butcher's rail under shade. There are many variations and systems for unloading and hanging bunches.

Dehanding

Fruit is dehanded using a thin bladed knife, a curved cutter or a modified jigsaw. Any obviously damaged or undersized fingers or hands are removed. Hands of fruit are washed in a water trough or rinsed on a packing wheel to avoid sap stain and to remove dirt (Figure 28). Use good quality water that is changed regularly and non-recirculating. The packing wheel also allows the fruit to be size graded on different levels of the wheel. Water misting may help to remove field heat.

Bunches must be inspected at this stage for 'Hard Green' compliance if they are to be sent to Victoria, South Australia or Western Australia under the ICA-16 arrangement, a Quality Assurance procedure designed to ensure fruit sent to these markets is free from Queensland fruit fly infection.

Postharvest treatment

As premium prices are paid for blemish-free fruit, postharvest dipping or spraying is recommended where postharvest disease has been a problem in recent market out-turns.

When using chemicals for postharvest treatment of fruit it is important to:

- use chemicals only at the rate given on the label;
- read label and use recommended safety precautions;
- avoid contact with skin;
- use clean water to make up the dip or spray tank;
- premix fungicide into a paste using a small quantity of water before adding to dipping tank;
- stir during use;
- top up volume with fresh dip as necessary;
- discard after 2500 kg of fruit has been dipped or after 1 week or if dip becomes dirty;



- dispose of dip into an earth pit to which lime is added, not into water storages or watercourses.

Good hygiene is an essential factor in post harvest disease control. Make sure that the inside the packing shed and area around it is kept clean and tidy so that old diseased plant debris and dirt do not act as a source of infection of freshly harvested fruit.

Grading, packing and labelling

Grading

Particular size and quality gradings exist for marketing in different states depending upon variety and specific packing methods are used for the various size grades of each variety. These general guides are available for use by growers, packers and their customers (agents and retailers) to accurately describe the fruit they have for sale. They illustrate and describe varieties, blemishes and defects found on fruit and size shape and colour characteristics of fruit.

- A manual *Product Description Language—Bananas* produced by Horticulture Australia Limited (HAL) for the Australian Banana Growers Council Inc. (ABGC). Also available are two posters which are companions to this publication, one showing photos of *Preharvest Defects of Bananas* and the other *Harvest and Postharvest Defects of Bananas*. This publication is available from ABGC Ph: 07 3220 0407.
- A booklet, *Product Description Language—Ladyfinger Bananas* published by the DPI Queensland which illustrates and detail fruit blemishes specifically associated with Ladyfinger fruit. This publication is available from the DPI Queensland's Maroochy Research Station, Ph: 07 5441 2211.
- A poster, *Chiquita Banana Quality Specifications*, which defines and illustrates blemish types, maximum permissible defect levels and size measurement procedure as established by Chiquita. This publication is available from Chiquita Brands South Pacific Ltd: Gary Fattore (NSW) Ph:0417 644 033 or Ben Franklin (QLD) Ph: 0417 610 571.
- *Ladyfinger Sizes* poster and *Ladyfinger Packing Guide* series, The *Ladyfinger Packing Standards: Grade 1'* poster and the *Ladyfinger Banana Produce Specifications Sheet* are available from Maroochy Research Station, PO Box 5083 SCMC, Nambour, Queensland 4560 Ph: 07 5441 2211.

Packing and labelling

Bananas are packed as whole hands or clusters of between three and eight fingers. Specific markets may have preferences so liaise with your customer.

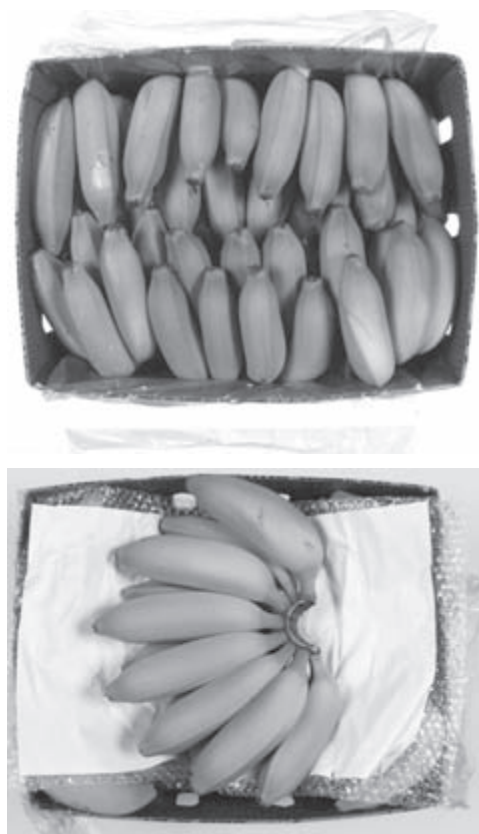


Figure 29. Ladyfinger fruit packed as clusters in a cluster pack (upper) and hands in a flat pack (lower)

There are also a number of different styles of packing dependant upon finger size and a range of carton sizes (8, 12 and 13kgs) and packing materials used (latex absorption sheets, carton liners and slip sheets). The system you use will depend on your target market. Some typical packing systems are shown in Figures 29 and 30.

Most bananas are packed in cartons or returnable crates. Pack cartons/crates to 0.5 kg above specified net weight to allow for moisture loss during transport and ripening. Use a polythene film insert (slip sheet) to pack into and wrap over the top of the fruit. Ensure the film does not obstruct ventilation slots. It is also a good idea to drill holes in the film to avoid water retention in the bottom of the carton. Absorbent paper may be placed in the bottom of the carton. Some growers also use bubble pack and plastic foam sheets for high quality Ladyfinger fruit packs.

If bananas are being sent to a central wholesale market they must be packed in clean, new, legibly printed containers with the following text:

- Packer's name and address or the registered trade mark of the packer.
- The size class.
- The quality class e.g., 'No. 1' or 'No. 2' class.
- Quantity statement e.g., 13 kg net.

Different packing systems are employed for each size grade. Packing guides are available from some wholesalers or DPI Queensland and NSW Agriculture offices.

5-hand length-
ways pack for
large fruit

4-hand length-
ways pack for
extra large fruit

Figure 30. Examples of packing patterns for Cavendish bananas



The most commonly used fruit size classes for Cavendish are shown in Table 10. Minor variations to these sizes occur, depending upon the wholesaler or agent and different standards may be developed for specialised markets. A typical finger on the outer whorl of each hand or cluster is used to assess the size of all the fruit in that hand or cluster. Measure from the tip of the pulp at one end of the banana to the tip of the pulp at the other end, along the outside curve of the fruit.

Table 10. The three size classes for Cavendish banana

Length (mm)	Minimum diameter (mm)	Minimum circumference (mm)
220 +	41	128
195 -220	35	110
150 -195	32	101

In the Cavendish market, there is no single universal standard for maximum fruit blemish that is accepted by the whole industry and used in all markets. Contact your customer and agree on what sort of fruit is required and what limitations on blemishes are appropriate for the market.

When measuring Ladyfinger fruit, choose a typical middle finger on the outer whorl of the hand or cluster. Do not measure wing fingers. For Ladyfinger bananas, four size classes are used (Table 11).

Table 11. Ladyfinger size classes

Length (mm)	Diameter (mm)	Circumference (mm)
185-205mm	45-55mm	140-175mm
155-185mm	38-48mm	120-150mm
135-155mm	35-40mm	110-125mm
110-135mm	27-37mm	85-115mm

Measure the distance from the base of the pulp at the flower end to the base of the pulp at the neck/cushion end along the outside curve. Measure the diameter or circumference at the widest point. The overlap in the diameter/circumference ranges between sizes, allows for seasonal variation in finger fill.

Packing standards for Ladyfinger bananas have been established for Grade 1 fruit. These are given in the: *Ladyfinger Packing Standards: Grade 1* poster and the *Ladyfinger Banana Produce Specifications Sheet*. Available from Maroochy Research Station, Ph: 0754 2211.

These posters are available to help industry standardise packing systems:

- The *Chiquita Banana Packaging and Appearance Guide* poster. Contact: Chiquita Brands South Pacific Ltd, Gary Fattore (NSW) Ph: 0417 644 033 or Ben Franklin (QLD) Ph: 0417 610 571
- A series of six *Ladyfinger Packing Guide* posters. Available from Maroochy Research Station, Ph: 0754 2211.



Transport, storage and ripening

Transport

Fruit is transported as palletised loads. While the number of farms with cold storage facilities is increasing, most fruit is cooled in cold stores at transport depots before dispatch.

Storage

Some points when handling and storing bananas.

- Do not store bananas below 13°C. These temperatures damage green or ripe bananas. A domestic refrigerator is far too cold.
- Bunches of green bananas stored at 14 to 16°C give off almost no heat or ethylene and can be stored for at least 2 weeks without ripening naturally.
- Ripening bananas give off heat and ethylene. They should not be stored near green bananas as the ethylene produced can cause the green bananas to ripen.
- Fruit ripened at temperatures above 26°C do not develop the full yellow skin colour like commercially ripened fruit even though the pulp ripens normally. This is called 'green ripe'.
- Do not store or transport with other ethylene-producing fruit.

Ripening

Wholesalers or merchants operating in the major markets generally carry out commercial banana ripening near the place where the ripe product is finally sold. Ripening must provide fruit with good eating quality, appearance and acceptable shelf life. The critical conditions of temperature, humidity, ethylene and carbon dioxide levels must be carefully controlled.

Two posters are available which both illustrate the 7 colour stages of ripening bananas:

- Australian Banana Growers Council's Banana Product Description Language Poster, *Harvest and Postharvest Defects of Bananas* available from the ABGC, Ph: 07 3220 0407
- Chiquita's *Consumer Colour Preference* guide available from Chiquita Brands South Pacific Ltd, Gary Fattore (NSW) Ph: 0417 644 033 or Ben Franklin (QLD) Ph: 0417 610 571



Marketing

You must decide where and how you are going to sell your fruit. The main options are:

- **Consign fruit to banana wholesale agents** or merchants in the major metropolitan wholesale produce markets. Wholesale agents sell your fruit to retailers on a commission basis. Wholesale merchants buy your fruit at an agreed price and then on-sell the fruit to retailers taking the profit /loss risk themselves; there is no commission under this arrangement. Most Queensland bananas are consigned to wholesale agents in Brisbane, Sydney, Melbourne and Adelaide. Wholesalers are in effect your source of market intelligence. For this reason, the choice of a wholesaler is extremely important. It is best to deal only with specialist banana wholesalers. Seek advice on selecting wholesalers from local growers in your area.
- **Join a marketing group** or co-operative where marketing decisions are made on a group basis. This is highly recommended as the combined resources and volume of product allow a greater range of marketing opportunities to be explored allowing individual growers much more marketing power.
- **Sell to a local distributor**, who sells to local shops and supermarkets.
- **Supply locally** to district retailers, resorts and restaurants. You have to organise your own ripening and sales and distribute the fruit yourself. This can be hard work but some growers find this rewarding.
- **Sell fruit from the farm.** To take advantage of this option you need to ripen the fruit yourself and need to be near large towns or have a great deal of passing traffic. It is important to have good road access to the farm. Also check on local authority requirements and take out public liability insurance.
- **Sell fruit at markets** (weekend or farmers' markets). As with other direct market options you will need to ripen the fruit before selling.
- **Sell direct to major chain stores** and fruit barns. These outlets require a regular supply of uniform quality fruit. This is only an option for either very large farms or marketing cooperatives.
- **Export.** This has complex and specialised requirements. Seek the advice of marketing groups or co-operatives. There is no significant export trade at present.



Marketing
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Whatever market outlet you choose, keep in close contact with your marketer and ask for feedback on the quality of your fruit in the marketplace. Visit the major market in which your fruit is sold at least once a season.



Harvesting & marketing

Interstate quarantine requirements

Each state has specific quarantine requirements that must be met. Interstate requirements are subject to change so contact your local DPI plant health officers. Officers in major DPI centres can assist businesses with inspection services. Growers are advised to confirm the details of requirements and fulfil these in advance, before sending banana produce interstate.

Levies

In Queensland a number of voluntary industry levies are currently payable and industry is looking at some compulsory options. In NSW levies based on the area of production are compulsory.

Recent trends in marketing and quality management

The demand for quality management systems at the farm and packhouse levels has grown significantly in recent times. The major catalyst for this has been the growing demand from consumers and retailers for safety standards for all food, including fruit. These standards include minimal chemical residues, lack of food contamination organisms, and freedom from foreign matter as well as other quality parameters such as good shelf life, colour and flavour. In addition, retailers are moving towards demanding individual produce labels containing PLUs (price look-up numbers).

At present, all major retailers have in place systems where produce is only purchased from suppliers that can guarantee food safety standards under a HACCP based food safety quality management system. Most fruit is currently supplied to retailers through produce wholesalers/agents who have to meet the HACCP requirements. This HACCP requirement is now being extended to growers by some supermarkets. In future, it is probable that other quality issues and PLUs on fruit will be required as conditions of approved supplier status. Without this status, growers can only supply the non-supermarket sector of the market that is minor and decreasing yearly.

Note that growers who wish to supply major retailers direct, need to implement an on-farm HACCP based quality management system such as *Freshcare*.

The quality management system includes:

- Product and handling specifications that outline how your bananas will be delivered.
- Product identification and traceability that shows you can identify all of the treatments applied to a consignment of fruit from the paddock through packing.

IMPORTANT

If your business substantially transforms your product, such as canning, peeling and juice production, or where product is sold or served direct to the public, such as farmers' markets and road side sale, your business will have to comply with the new *Food Safety Standards*.

more info



Planting permits/
material supplies
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Quality management
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- Staff training that shows the person responsible for chemical application is appropriately trained and that packing staff are trained in product specification and personal hygiene standards.
- Measures to control quality hazards that show you are aware of where quality could be compromised and that you have procedures in place to ensure that these hazards are minimised.
- Measures to control food safety hazards that show you apply only approved chemicals, observe withholding periods and prevent contamination of the fruit by objects such as wood or glass. You must also be able to show that you keep equipment clean and that staff handling the produce observe good hygiene. You will need to maintain records of your spray applications.
- Packing premises are constructed and maintained to prevent physical, chemical or microbial contamination of packages or produce at any time.
- Keep written records to demonstrate compliance with the above requirements.

Markets and importing countries may soon demand assurances for best practices in all sections of the industry. This may include proof of sustainable environmental practices in the future. It is important that growers are ready for this change and start to develop a quality management system at the farm level now.