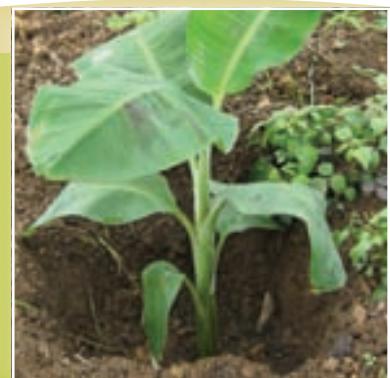


Banana Growing Guide

Cavendish Bananas

Peter Newley & Arthur Akehurst
NSW Department of Primary Industries

Bob Campbell
Bananas NSW



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Banana Growing Guide

Cavendish Bananas

Peter Newley & Arthur Akehurst
NSW Department of Primary Industries

Bob Campbell
Bananas NSW



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Title: Banana Growing Guide: Cavendish
Bananas

Authors: P Newley, A Akehurst & B Campbell

Published by NSW Department of Primary
Industries

© State of New South Wales (2008).

You may copy, distribute, display, download and otherwise freely deal with this publication for any purpose, provided that you attribute the department as the owner. However, you must obtain permission if you wish to charge others for access to the publication (other than at cost); include the publication in advertising or a product for sale; modify the publication; or re-publish the publication on a website.

First published October 2008

ISBN 978 0 7347 1904 1

About this guide

This guide has been developed by NSW DPI and Bananas NSW, using our combined technical resources, and above all, the experience of some very successful growers.

This Cavendish growing guide is one of a set of publications for banana growers. It gives details of crop management activities for Cavendish banana production in the plantation and packing shed. Other publications from NSW DPI cover pest and disease management and sustainable banana growing.

Another publication *What the good growers do* also gives an insight into the production and management practices of 23 of NSW's top banana growers. This highlights the practices and philosophies of these successful growers, and spells out their priorities. We recommend the *What the good growers do* guide as a great starting point for new growers or a refresher for established growers looking to move ahead. It is available from NSW DPI or Bananas NSW.

Current contacts within the contributing organisations are listed below.

NSW Department of Primary Industries.

Murwillumbah Office – Arthur Akehurst

Coffs Harbour Office – Peter Newley

Bananas NSW

Murwillumbah – Bob Campbell

This document is part of a set of publications. The remaining parts of the set can be found at www.dpi.nsw.gov.au. Updated versions of this document will also be found at the above web address.

Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (2008). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of NSW DPI or the user's independent adviser.

The product trade names in this publication are supplied on the understanding that no preference between equivalent products is intended and that the inclusion of a product name does not imply endorsement by NSW DPI over any equivalent product from another manufacturer.

TABLE OF CONTENTS

Bananas • 1	In the shed – presentation pays in the markets • 18
Preparation and establishment – setting the scene for success • 2	Unload and de-hand with care: 18
Site selection: 2	Packing tips: 19
Site preparation: 2	Keep the shed clean: 20
What to plant: 3	Transport your fruit carefully: 20
The Panama disease checklist: 5	
How to plant: 6	
Planting to bunching – keeping the plants growing well • 8	Sustainable banana production – looking after your farm • 21
Correct nutrition: 8	Healthy soils: 21
Irrigation: 8	Integrated pest management: 21
Desuckering: 9	Water usage: 22
Keep the leaves healthy: 9	Windbreaks and other vegetation: 22
Keep the roots healthy: 10	Environmental management systems: 22
Manage the weeds and cover crop: 11	
Bunching to harvest – producing quality bunches • 13	Meeting market access requirements • 23
Bunch covering and pruning: 13	
Monitor for bunch pests: 14	
Fruit disease control: 15	
Fruit bat and bird control: 15	
Harvesting quality bunches – cut fruit at the right time • 16	
Harvesting at the right maturity: 16	
Cutting the bunches: 17	

BANANAS

The Cavendish variety accounts for over 90% of Australian production and has a loyal following amongst consumers. The industry often produces more fruit than the markets require and prices can be poor for extended periods. This is reflected in the wide range of prices for Cavendish bananas in wholesale markets from season to season. When the market is over supplied fruit quality is important as returns for poor quality fruit do not cover costs of production.

The Cavendish variety includes varieties commonly referred to as Hybrids, Williams, Mons or Dwarf Cavendish.

The ladyfinger variety makes up the majority of the remaining crop and has a ready following, particularly in the Brisbane area. The goldfinger variety also has a small following in Brisbane and small quantities of other varieties are available in the market place.

Consistent quality is the key to profitable banana production and this is the major focus of this manual.

Growing quality bananas all year round in a sub-tropical climate is not easy. As well as pests and diseases, environmentally induced problems, such as chilled fruit during winter and November dumps have to be managed.

These challenges can be met, and this Grower Guide is one step towards seeing Best Practice adopted in the banana industry.

One special caution. Bananas suffer from a soil-borne fungal disease known as Panama disease which kills the plants. Race 1 affects ladyfinger and other similar varieties and subtropical Race 4 affects ladyfinger and Cavendish plants. It is a major threat to the industry's future. The Panama fungus is spread by movement of infected plants or soil. If you get Panama disease on your property, you cannot get rid of it, so be sure your planting material comes from a clean source or you may be planting problems with your plants. The more detailed Agnote *Panama disease - on-farm management* is available at www.dpi.nsw.gov.au

PREPARATION AND ESTABLISHMENT – SETTING THE SCENE FOR SUCCESS

Site selection

To grow a good plantation choose a frost-free site, sheltered from strong winds on a workable slope. Banana plants are susceptible to blow out with strong winds so shelter is important. North east to north slopes are best because they are warmer and sheltered from cold south westerly winds. The ideal temperature for bananas is 27°C to 30°C. Growth is very limited below 13°C and chlorophyll is damaged below 6°C.

Bananas grown on cool sites have:

- inferior fruit quality
- higher incidence of *Deightoniella* disease
- dull grey winter/spring fruit
- stale fruit
- slower ratooning
- more frequent treatment for fruit pests and diseases
- lower production.

A permit to plant and move bananas must be obtained from your local NSW DPI Regulatory Officer before you begin.

Site preparation

Bananas grow best in fertile soil that is free of pests, diseases and competition from weeds.

If the ground is free of Panama disease every effort should be made to keep it that way. Clean planting material is essential as diseased planting material is the major means of spreading Panama disease. Tissue cultured plants are the only guaranteed clean material. It is also worthwhile to make sure any machinery being used is clean before it enters the farm. See the Panama checklist on page 5 for more details.

When replanting a ladyfinger plantation with Cavendish where Panama disease has been a problem, clean planting material should also be used for best results.

Preparing new ground

If you are starting from scratch and clearing a new site, the design of the roadways should aim to maximise the efficiency of the patch and minimise soil erosion. Well formed, smooth roads will minimise fruit damage during transport from the plantation to the shed. When clearing, sites that could harbour vermin such as weedy patches, logs, stumps, lantana, old tins, etc. should be cleaned up.

Take samples for a soil test and follow the recommendations. This is the time to get the soil pH and nutrients right so the plants get a good start. The ideal range for soil pH is 5.5 to 6.5. The soil should also be of reasonable depth to allow development of strong root systems. Siting plantations on shallow, stony soils can result in blowovers during high winds.

Once cleared, protect the soil from erosion with a cover crop. Cover crops will also minimise weed growth and provide mulch for the soil. See the recommendations on cover crops on page 11. On recently cleared ground, a mix of short and long term cover crops can be useful.

If the land is cleared in spring, use a mix of millet, which is cheap and easy to establish and manage plus broadleaf paspalum, which will persist in the established plantation.

When land is cleared in autumn either ryegrass or a mix of oats and broadleaf paspalum is recommended. If grasses are considered a problem, an autumn sowing of white clovers may be an option.

Much of the cover crop can be kept when preparing for planting by spraying out a 1 metre strip along the row or 1 metre circles at each planting site.

- Note: avoid autumn clearing if possible, as there is a higher risk of erosion from storm rains.
- Don't forget to fertilise the cover crop.

PREPARATION AND ESTABLISHMENT – SETTING THE SCENE FOR SUCCESS

When replanting a spelled patch

Replanting with bits or corms in the cooler subtropics is carried out from September to December. When replanting using tissue cultured plants this should be done as soon as the plants are available, usually around Christmas time.

The best method of killing the old plantation is to inject the plants with a herbicide. The old plants will help protect the soil until the cover crop is established. A cover crop can be established as the old plantation is being destroyed.

- Do not cut down old banana plants before injecting with a herbicide. This needs to happen at least six months but preferably two years before the new planting commences. This will give sufficient time to eliminate banana weevil borer (which can persist in the dead corms of plants for many months), nematodes and bunchy top disease. Most growers would agree that anything less than two years out of bananas gives disappointing results.

Pushing over and track walking with a dozer is another method of destroying an old plantation prior to replanting. This has to be considered second best to injecting a herbicide. The dozer can introduce Panama to the plantation and could create an erosion problem.

A soil test should be taken early enough to apply lime and other soil amendments as required before the planting season, ideally before the ground is ripped in preparation for planting.

Spray off the cover crop in strips one metre wide or circles 1 metre in diameter, well before replanting, but keep the rest of the cover crop growing as protection against soil erosion and weed invasion.

What to plant

When establishing any banana plantation it makes sense to commence with the best quality planting material available. The use of poor quality planting material or planting material of unknown origin will put the long-term viability of a plantation at risk.

Panama and bunchy top diseases, nematodes, banana weevil borer and rust thrips can all be introduced to a plantation in contaminated planting material. Once they are introduced the viability of a plantation is decreased.



Tissue cultured plants almost ready for planting.

PREPARATION AND ESTABLISHMENT – SETTING THE SCENE FOR SUCCESS

Planting material choices

Growers have the choice of tissue-cultured plants (directly planted in the plantation or via a nursery block) or conventional corm bits and suckers. Each of these has different levels of pest and disease risk. Tissue-cultured plants go a long way to reducing risks and are by far the preferred option.

Choice 1 Tissue-cultured plants

The use of tissue-cultured plants virtually eliminates the chance of introducing pests or disease into a plantation with the planting material. Many growers in NSW and Queensland use tissue cultured plants and are happy with the results.

Tissue-cultured plants are tough enough to plant directly into the field provided:

- they are a good size (preferably 10 leaves) and in good condition when they are planted
- they are hardened off in full sun with regular watering for two weeks before planting
- they are watered-in well at planting
- if conditions are dry, they are given some follow up water (a few litres per plant is enough to get by)

- banana weevil borer have been eliminated from the site (by spelling the ground).

Remember, order your tissue cultured plants well ahead of planting time (15 to 18 months) to be sure of having them available at the right time.

Choice 2 Nursery blocks

Some banana growers are still wary of paying the upfront costs of buying tissue-cultured plants to establish a plantation and prefer to use conventional corm bits and suckers. If this is the case growers can obtain most of the benefits of clean planting material by establishing a nursery block with tissue-cultured plants in clean ground and harvesting the corm bits and suckers 10 months later. Nursery blocks also allow you to detect and remove any off-types in the nursery block.

Planting material obtained from a nursery block established with tissue-cultured plants is second best to tissue-cultured plants, but much better than material obtained from an established plantation which is likely to carry pests and diseases. See the nursery block publication at www.dpi.nsw.gov.au for more details.

Choice 3

Corm bits and suckers – from your own plantation

Using planting material from your own plantation puts you at risk of spreading existing problems like Panama disease, bunchy top disease, nematodes, rust thrips and weevil borers, which will reduce the productivity of your new patch. However this choice at least ensures you do not introduce new problems to your plantation that you don't already have.

Choice 4

Corm bits and suckers – from another plantation

(Subject to planting regulations)

If planting material from one of the three sources mentioned above isn't available, a less desirable fourth choice is material from a neighbour's plantation. However, this method carries a risk of introducing Panama, bunchy top, nematodes, rust thrips or banana weevil borer into your plantation. You are likely to plant pests and diseases along with your bananas. This really is a poor option.

PREPARATION AND ESTABLISHMENT – SETTING THE SCENE FOR SUCCESS

The Panama disease checklist

Avoiding the introduction of Panama disease (caused by the fungus *Fusarium oxysporum f. sp. cubense*) is important to all banana growers. If you introduce Panama into your farm on Cavendish suckers it can persist for decades and will make growing susceptible varieties such as ladyfinger unviable for many years to come. To keep Panama disease out you need to note the following points.

- Help reduce movement of possibly Panama infected soil by protecting all exposed soil, especially waterways, with cover crops. This minimises soil erosion and reduces the chances of spreading Panama around the plantation.
- Keep the movement of vehicles during wet weather to a minimum to limit the movement of soil within the plantation.
- Do not spread discarded bunch stalks in the plantation as they can carry the disease.



A quarantine sign at the entry to a banana farm.

PREPARATION AND ESTABLISHMENT – SETTING THE SCENE FOR SUCCESS

- Avoid second hand cartons as they can be contaminated with Panama disease infected soil.

Remember, contaminated planting material and contaminated soil are your two biggest enemies for spreading Panama disease.

The more detailed Agnote *Panama Disease – on-farm management* is available at www.dpi.nsw.gov.au

How to plant

Get the plant spacing right

Plant spacing affects the amount of sunlight and soil available to each plant. Cavendish plants require about 7 sq m per plant and are usually planted at 3.0 m by 2.4 m.

The effects of plant spacing

- Bunch size and grade (plant too close and the bunches will be small with smaller fruit).
- Bunch cycling (plant too close and the followers will be slower bunching and bunches slower filling).
- Disease problems – closer plantings have reduced air circulation, and as a result fungal leaf diseases including Deightonella will be worse.

Planting tissue cultured plants

Tissue cultured plants are tougher than they may appear and are quite capable of surviving most field conditions if they are hardened off in full sun for two weeks before planting. Water them several times each day during this period.

Only purchase tissue culture plants from an industry accredited nursery. The plants should preferably have at least 10 leaves; any less and they are hard to check for off-types.

Tissue-cultured plants should be planted approximately one month later than conventional planting material. The reality is that plants are usually not available from the nursery until December anyway.

Cull any suspicious looking plants. If you are uncertain and are not prepared to throw them out, then plant them at the end of a row so that any replacements will not be shaded out.



Tissue cultured plants are planted deep in the hole them backfilled.

PREPARATION AND ESTABLISHMENT – SETTING THE SCENE FOR SUCCESS

To get the best from your tissue-cultured plants try to plant them into well-rested ground – at least two years without banana plants is best. Tissue-cultured plants can be especially susceptible to nematodes and banana weevil borer so a 2-year rest is very important.

- Mark out for the chosen plant spacing. A deep contour rip is good for easy planting and retaining moisture. Do not rip up and down the hill.
- Spray the cover crop out in strips along the slope or circles about 1 metre wide, well before planting time. This will provide mulch at the planting site, conserve moisture and reduce weed growth.
- Pull back the mulch and dig a hole about 35 cm deep.
- Place any fertiliser (usually about 200 g superphosphate) in the hole. Put 5 cm of soil back in the hole and mix in the fertiliser.
- Make sure the plant is well watered before you take it to the patch.
- Slip off the pot without disturbing the roots, place in the hole and back fill, making sure that all clods are broken up. Compact the soil around the root ball to ensure that no air pockets are left. It is a good idea to create a small basin around the plant to catch rainfall and help with hand watering if required later.

Plant deeper than for bits or suckers. Have the top of the potting media 15–20 cm below the top of the hole. The plant needs at least three litres of water to wet the soil and help expel air from around the root ball.

After that the plant will then survive with minimal watering. Regular watering will, however, improve growth and hasten bunching.

Planting bits and suckers

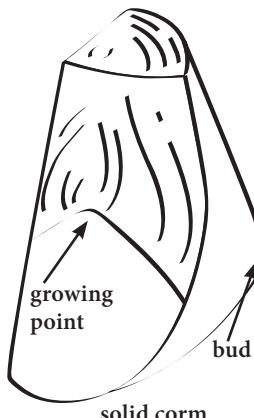
Dig a hole 30 cm deep, place 200 g superphosphate in the bottom and fill in 5 cm of soil. Place the bit in the hole on a 45° angle so the bud points towards the bottom of the hole and faces uphill as shown in the diagram. Fill in the hole with soil and firm the soil around the bit.

Suckers are planted in a similar manner. A hole is dug and fertiliser is placed in the hole the same as for bits. The sucker is placed in the hole on a 45° angle with the most developed bud pointing towards the bottom of the hole and facing uphill.

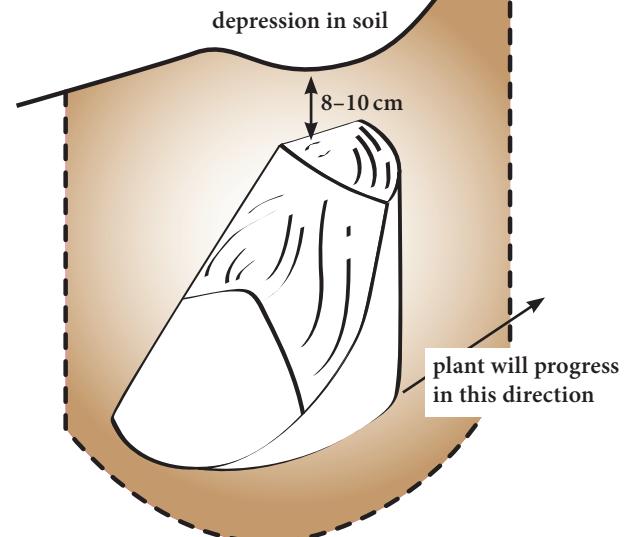
Remember: before planting bananas in NSW growers must obtain a permit to plant and/or move bananas from their District Regulatory Officer.

Movement of banana planting material into and within NSW is subject to restrictions based on disease quarantine zones. The Regulatory Officer will need to know the source of the planting material before a ‘permit for movement and planting of banana plant material’ can be issued.

piece ready for planting



piece in hole in ground



Corm bits should be planted with the bud facing uphill.

PLANTING TO BUNCHING – KEEPING THE PLANTS GROWING WELL

Correct nutrition

Healthy, vigorous planting material that is well looked after will bunch inside 12 months with first harvest by 18 months. This bunch should yield two cartons, with a new bunch each 12 to 16 months from then on.

Good growing conditions give best returns of high quality, high value fruit. That means managing soil fertility, irrigating if possible and keeping competition from sucker and weed growth under control. Good management of leaf disease will also contribute to a healthy plantation.

Fertilising – deciding what and how much to apply

A well managed nutrition program starts before planting. Take a soil test to establish an effective, economical fertiliser program. Bananas perform best in soils where the pH is over 5.0, phosphorous is more than 80 ppm, potassium is above 0.5 meq/kg, calcium is between 4 and 10 meq/kg, and magnesium is between 1 and 3 meq/kg.

Zinc and boron levels are likely to be low in north coast soils so these should also be checked when the soil test is done. The electrical conductivity (EC) should be below 0.15. For more information about fertiliser programs talk to your local District Horticulturist.

If lime, phosphorous or micro-nutrients are needed, they can be applied before planting. Once the plants are in the ground, the fertiliser program is determined from the soil test results

for the first season and by soil and leaf tests after that. Applying fertiliser on a plantation without any idea of its fertility status can miss supplying nutrients that are low or cause dangerously high levels to build up and create soil nutrient imbalances or plant toxicities.

Once you have a recommendation for the amount of fertiliser needed, calculate how much you need to apply in 6 to 8 applications to reach the annual target. Do not apply fertiliser in a few big applications as this can get washed away before it all gets incorporated into the soil if a storm comes.

Generally for banana crops, the application rates for major nutrients should be in the region of: nitrogen 100 kg/ha, phosphorous 60–90 kg/ha and potassium about 220 kg/ha. This will replace the nutrients used by the crop over a year.

Fertilising young plants

Apply the fertiliser within a circle not closer than 15 cm around the plant (keep away from the funnel leaf to avoid burns).

Continue applying fertiliser each month, widening the circle out each time to keep slightly ahead of root growth until you start broadcasting over all the inter-row area from six months onwards.

Aim to apply small doses every warm month but wait for 4 weeks after effective rain (about 30 mm) for fertiliser to be washed in. So in practice you would apply 6–8 applications per year.

Nothing beats fertigation as a system for optimum production. It delivers the right amount of nutrient, together with the water needed for the plant to take it up, and allows for the little and often approach.

Fertilising established crops

Take samples for soil and leaf analysis in April/May each year once the plantation is in production. This will allow for the annual fertiliser requirements to be calculated and allow time for any lime or dolomite applications to be applied before the fertiliser program commences in the next spring. It is best to broadcast fertiliser over the whole interrow in established bananas.

Irrigation

Bananas grow much more consistently and cycle faster if they are not water stressed. They have a relatively high water use in the heat of summer but only have a shallow root system. This means soil moisture reserves are used up very quickly, particularly in light or gravelly soils.

At the peak of the season a plantation can use up to 50 mm of soil moisture a week. Soil moisture levels should be monitored with tensiometers or similar devices and irrigation decisions made in response to this information.

An irrigation system should be designed to allow for irrigating each section at least weekly.

PLANTING TO BUNCHING – KEEPING THE PLANTS GROWING WELL

Desuckering

Banana plants begin to produce suckers a few months after planting. These suckers compete with the main plant for water and nutrients and will reduce productivity if left to grow, so regular desuckering is required for maximum production. Desuckering also allows better air circulation through the plantation which assists with disease management.

Tissue cultured plants

Take off all suckers as they emerge for the first 5–6 months, using a dehanding knife and diesel at ground level. Then select the first follower in the correct position and continue to remove all other suckers monthly with a gouge.

Bits and suckers

Aim to have a follower selected and all other suckers removed by six months. Excess suckers left longer than this will reduce yield.

If a sucker is greater than 15 cm in diameter it may have formed its own eyes. If the sucker is killed these eyes may grow to form a circle of suckers that will have to be removed.

Diesel desuckering is favoured by many growers as quick, easy and effective. There is a permit for its use.

With diesel desuckering it is important to apply the diesel to the growing point. Each growing point must be treated. Do not attempt to inject into the hard white corm, as this will not work.

Keep the leaves healthy

Leaf disease control

The main leaf diseases of concern are leaf spot and leaf speckle which cause early defoliation of the banana plants. This loss of leaves slows down bunch filling. The aim should be to have at least one green leaf per hand of fruit at harvest time.

Leaf spot and speckle affect newly emerged leaves in summer and early autumn (see photo on page 10).

The first step of a control program is the removal of diseased leaves to decrease the infection pressure in the plantation. This is known as ‘green deleaving’ where leaves with more than a quarter of their surface area affected by spot or speckle are cut down. Some growers remove leaves with even less disease. If disease levels are severe enough and deleaving on its own will not give adequate control, a spray program will be required.



When desuckering leave one sucker on the uphill side of the plant.

PLANTING TO BUNCHING – KEEPING THE PLANTS GROWING WELL

Keep the roots healthy

Keep root and corm pests away

There are root and corm pests which can decrease the vigour of the plantation if allowed to multiply to significant numbers. The easiest way to keep them out of a new patch is to use tissue culture plants from an accredited nursery. This will give several years before treatment is required.

Banana weevil borer

Banana weevil borer is easily managed as long as large numbers are not allowed to build up. Attention to good hygiene is the simple basis for control. Split up any fallen stems so that they dry quickly and deny the weevils extra breeding grounds. Where banana weevil borer numbers reach high levels and treatment is required, inject the old residual plant stems in June and September. If populations are very high, butt sprays may be needed; however they are expensive and are best considered as a last resort. It may be necessary to spray plant crops as they have no spent stem suitable for injection until six months after the

bunch has been harvested. If virgin or well spelled land and clean planting material have been used it should not be necessary to treat for banana weevil borer for several years.

Nematodes

Cavendish bananas are susceptible to damage by burrowing and lesion nematodes in particular but not always enough to make treatment with nematicides economic in our environment. Spelling the ground for at least two years under a suitable cover crop will greatly reduce nematode populations and would be a useful management strategy if heavy nematode infestations are encountered in older plantings. Planting material free of nematodes must be used to obtain maximum benefit.

Maintaining a healthy soil (high organic matter without excessive fertiliser and soil pesticides) also helps to reduce nematode impact. Such soil encourages healthy root growth and higher levels of beneficial organisms that can reduce nematode populations.

A good rule of thumb for managing nematodes is to get all the other things, like fertiliser, soil health, plant age and cropping right in the first place, and then think about nematode damage if there is still a problem.



Yellow sigatoka leaf spot will kill leaves if not controlled.

PLANTING TO BUNCHING – KEEPING THE PLANTS GROWING WELL

Manage the weeds and cover crop

Weeds and cover crops in the plantation need to be managed carefully to protect the soil from erosion and maximise soil health benefits without reducing the productivity of the plantation.

An established cover crop will minimise soil erosion, protect waterways and help keep weeds down without constant spraying. Cover crops and weeds will compete with banana plants for nutrients and water, particularly during establishment, so it is necessary to spray out part of the cover crop close to the plants to minimise competition. In practice this means spraying out a strip along the row at planting and widening it as the roots extend out from the row.

It is law that all vegetation within 1 metre of the base of the plant should be less than 30 cm high. This is to help with detection of the bunchy top virus.

Managing cover crops before planting

Cover crops can be established well before the crop is planted and should be sprayed out around the planting sites a few weeks before planting. This leaves either covercrop or weeds growing between the rows in the young bananas. This is better than a ‘bare earth’ policy as it protects soil from erosion until mulch builds up and also improves water penetration into the soil.

The area close to the plants will need weed control to minimise competition. Careful use of an appropriate non-systemic herbicide will knock down weeds for best control without damaging the young plants.

Note:

- Do not allow herbicide spray to contact leaves or stems of young banana plants; Basta is a much lower risk than systemic herbicides.
- Treat regularly according to weed growth to remove competition.
- A mulch of dead weeds is better than bare earth.
- Not all herbicides control all weeds – check the label to match the types of weeds you need to control.

Try to use several types of herbicide each year. The continuous use of one herbicide can lead to an upsurge in weeds that are not controlled by that particular herbicide.

Managing cover crops in young plantations

Spot spray around plants with a non-systemic herbicide for weed control if required.

No inter-row weed control should be needed for at least six months if the cover crop is well established.

Progressively increase the width of the sprayed strips until at 12 months there should be about a metre strip of cover crop left up the middle of each row.

Cover crops in established plantations

Using a spray of a non-systemic herbicide to reduce competition for water from grass strips may be necessary in spring and summer if the plantation is not irrigated.

If you are establishing broadleaf paspalum as a cover crop excessive growth of weeds can be sprayed with a non-systemic herbicide without killing the paspalum.

An alternative is to spray out the cover crop and weeds and then broadcast low growing turf varieties of ryegrass in late summer. These grow well through the winter and will last through until the following season. This reduces herbicide applications and improves soil health.

Option 1

Using turf varieties of ryegrass (*Lolium perenne*)

- Turf varieties of ryegrass are low growing and do not run to seed as readily as pasture varieties.
- They establish best in autumn.
- Broadcast the ryegrass seed after any weeds in the patch have been sprayed out.
- When planted thickly the ryegrass will block the light and inhibit germination of other weeds.
- A ryegrass cover crop sprayed out in spring will give the soil some protection through summer and can be replanted again in the autumn.

PLANTING TO BUNCHING – KEEPING THE PLANTS GROWING WELL

Option 2

**Using broadleaf paspalum
(*Paspalum dilatatum*) for replant areas**

- Takes 2 years to get a full establishment so plan ahead and plant in summer.
- Annual weeds in the first year will be smothered next winter.
- No inter-row weed control needed for at least six months.
- Spot spray around plants for weed control if required.
- Spray the paspalum back after it seeds in late autumn.
- Excessive growth of weeds or paspalum can be sprayed with a light spray of a non-systemic herbicide without killing the paspalum.

Option 3

**Using molasses grass
(*Melinis minutiflora*)**

- Takes two years to get a full establishment – plan ahead and plant in summer.
- It will harbour burrowing nematodes so it is not the best choice in areas where these nematodes are important. If in doubt about burrowing nematodes use a different cover crop.
- Annual weeds from the first year will be smothered in winter.
- While molasses grass is similar to broadleaf paspalum up to early crop establishment, it won't persist in long term plantations in the same way that paspalum does. Therefore molasses grass is good for establishment but not as good for a long term cover crop.

Other cover crops

There are undoubtedly other cover crops that are not too competitive or unmanageable. Check what your fellow growers are doing.

Some other crops that have been used are listed below.

Spring

- Millet is cheap and easy to establish and manage, or better still a mixture of millet and paspalum.
- Sweet smother grass (*Dactyloctenium australe*) persists well in low light situations, and is widely used in other north coast horticultural industries but grows long and rank like kikuyu unless it can be mown.

Autumn

- Oats are cheap and easy to establish and manage.
- Follow up the autumn cover crop with planting of paspalum; however it is better to sow oats and paspalum together in autumn. Some growers have also successfully used Namoi woolly pod vetch.

Reminder: don't forget to fertilise the cover crop.



Ryegrass protects the soil in a plant crop of bananas.

BUNCHING TO HARVEST – PRODUCING QUALITY BUNCHES

Bunch covering and pruning

Why is it important to cover bunches?

- Covers protect fruit against sunburn, bats, birds, insects and leaf rub.
- Covers keep all fruit on the bunch at the same temperature for more even fruit filling.
- Different coloured bags help identify bunch emergence time for harvest scheduling and crop forecasting.

What kind of bunch cover?

There is a range of bunch covers in either plain colours (e.g. blue, green, yellow) or silver on one side with a colour on the other. Using a range of different colours through the year, with a different one for each month, makes for efficient harvesting.

Many growers recommend using double bunch covers for winter hanging bunches to reduce wind rub damage and promote more rapid filling.

Make sure the covers are long enough to completely cover the bunches. Do not use dirty bunch covers as these can lead to poor fruit quality. Either clean used bunch covers or throw them away (at the tip, not in the plantation).

When to cover

Covers protect the bunches from damage so should be put on as soon as possible.

All of the best growers cover at least fortnightly and treat this as a high priority job when things get busy.

Prune before covering

Most growers prune the bunch when the cover goes on. A particular number of hands are left on the bunch, depending on the season. In general, bunches which will fill through summer are pruned to eight hands and bunches which will fill in winter are pruned to six hands. Heavier bunch pruning to six hands in autumn will reduce cycling time and reduce fruit blemish that occurs over the cold of winter.

Prune the bunch with a sharp knife or by breaking by hand. If possible, leave one or two fingers below the last full hand to promote sap flow and help retain the green stem below the bottom hand as a buffer against damage after harvest. Then remove any bracts and leaves that may rub against the fruit and put the cover in place.

Propping

Cavendish plants need propping and the best practice is to double prop at or before bunch covering.



This bunch is due for pruning and bagging.

BUNCHING TO HARVEST – PRODUCING QUALITY BUNCHES

Monitor for bunch pests

Banana flower thrips

Banana flower thrips can be an important pest of Cavendish fruit if corky scab occurs in the plantation. They also cause pimpling on young fruit but this does not persist as a blemish on mature fruit.

Banana flower thrips are active from late spring to early winter. It is easy to decide when to start treating for thrips in the spring. Check the skin of fruit that is removed during bunch pruning in spring, by rubbing your finger along the fruit to detect pimpling. When there are five or so pimples per fruit the thrips are likely to remain active through to late autumn or early winter. The same check on fruit in late autumn will let you know when you can stop treating.

Banana flower thrips damage the fruit **before** the bracts have lifted, and grower experience shows a throat spray before the bunch emerges is effective, as is bell injection.

Banana rust thrips

These thrips attack the bunch after it is fully emerged causing rust coloured, blemishes between fingers, where they touch tightly. If it is present, and you are treating for sugarcane bud moth, this should control the banana rust thrips problem as well.

Sugarcane bud moth

The caterpillar of this moth attacks the fruit any time after the bunch is fully open. The caterpillar feeds on the flower ends at first, and then moves between the fingers where it scars the surface. There is also fine webbing and frass. Treating the bunch at the time of bunch pruning can control it. Do not treat unless there is a history of caterpillar problems in the plantation – it will not suddenly appear in damaging numbers in the course of one season. Attack can occur at any time of the year but is generally unlikely on bunches that emerge in the winter.

Scab moth

Scab moth is not in the subtropical banana growing regions. Bell injection for this pest applies to North Queensland only.

Soldier fly

Soldier fly adults appear to be attracted to very newly emerged fingers, just as the bracts are beginning to lift. It lays its eggs between the fingers and the emerging larvae feed on the skin, leaving shallow scars in discrete patches.

The problem appears to be getting more common, probably because of the increasing move towards very early bunch covering, which provides them with a suitable environment.

Sooty mould

Sooty mould is a growth of black mould on the surface of the fruit. It only occurs when honeydew is present. The honeydew in turn is secreted by sap-sucking insects, commonly aphids or mealy bugs. If infestations of these insects persist at the top of the bunch then it may be worthwhile treating to remove them. However it is important to do this carefully, to avoid stirring up even bigger insect pest problems through killing of beneficial insects. It is a good idea to discuss this with your District Horticulturist if you are having persistent problems.

Finally, the sooty mould can be washed and rubbed off the fruit but it is a time consuming job and not economical.

BUNCHING TO HARVEST – PRODUCING QUALITY BUNCHES

Fruit disease control

Deightonella is an important fruit disease in Cavendish, especially in the southern zone of NSW. It causes small dark spots on the skin and is an important skin blemish. Some growers know it as 'salt and pepper'. Deightonella spreads to the bunch from dead diseased leaves. It may not always be obvious when fruit is packed but may become so during storage or ripening. Seek feedback from your merchant.

Deightonella can be controlled provided a number of simple procedures are followed. Remove diseased leaves regularly. This is particularly important coming out of spring so aim to remove all diseased leaves before the beginning of October. A mancozeb leaf spray should then be applied in October, if Deightonella has been a problem. If these two measures do not eliminate serious fruit damage then a bunch treatment with a dusting formulation can be used on the newly emerged bunch.

Chemical training

Training and certification as an accredited chemical user is necessary for anyone applying pesticides as part of their employment or business. Keeping records of pesticide applications is mandatory in NSW.

Fruit bat and bird control

Fruit bats and birds can cause considerable damage to fruit as they climb over bunches while feeding. They are attracted to the bells at emergence as well as any ripe fruit in the plantation, although Cavendish bells are not as attractive to fruit bats and birds as are ladyfinger and goldfinger bells. Fruit bats will also attack mature green Cavendish bunches and damaged fruit.

There are a number of precautions that growers can take to reduce this problem.

- Do not allow any ripe bunches to remain in the plantation as the ripe fruit will emit ethylene which attracts fruit bats. The ripe fruit also attracts birds.
- Do not grow other fruit in the plantation as this ripe fruit will also attract fruit bats, birds and possums.
- Do not dispose of rubbish fruit in the plantation, as this will also attract birds.
- Scrub turkeys are becoming a major problem in some growing areas. They are capable of destroying bunches as they feed. Fallen bunches left lying on the ground and waste fruit dumped in the plantation will attract them to a plantation. If this fruit was dumped some distance from the plantation they may be attracted away from the plantation.

HARVESTING QUALITY BUNCHES – CUT FRUIT AT THE RIGHT TIME

Harvesting at the right maturity

When fruit begins ripening after harvest the sugar levels in the pulp increase. As this happens water is drawn from the skin into the pulp, the pulp swells and the skin gets thinner. This causes fruit that is too full at harvest to split. Fruit which looks round at harvest is too far gone to survive the commercial ripening process intact. In practice this means the fruit should still have noticeable corners at harvest. Talk to your wholesaler to get feedback on the best fruit to harvest for the best prices.

Deciding which bunches to harvest

- Look for the cover colour you are harvesting that month.
- Check the fruit for maturity.
- Cut when the fingers are 75% full and the corners are still a bit square.
- The age of the bunch seems to be an important issue for fruit quality so when using bunch covering of a different colour each month follow the rule that when approximately 80% of a particular colour is harvested cut the rest of that colour within the next few weeks.

A range of factors can influence fruit filling:

- Aspect – sunnier slopes promote faster filling.
- Planting density – closer plantings can be slow filling.
- Rainfall and temperatures – either dry or cool conditions can slow filling.
- Leaf disease – control must be maintained – aim for a minimum of one green leaf per hand at harvest.
- Leaf damage from wind.
- Nutrient imbalances will cause slow fruit filling. This particularly applies to potassium and magnesium.
- Bunch pruning – heavily pruned bunches will fill faster.

Many November and December bunches have fruit that is abnormally shaped in some way. Some fruit is abnormally short and is known as November dumps. Some fruit from these bunches will not be worth packing.

Avoid maturity bronzing

Maturity bronzing is a bronze coloured mark on the skin of the fruit which occurs when the fruit gets too full. Sometimes growers may have to harvest fruit thinner than the normal 75% full during problem months.



Fruit at harvest should still have corners so they don't split when ripe.

HARVESTING QUALITY BUNCHES – CUT FRUIT AT THE RIGHT TIME

Cutting the bunches

Be careful with the bunches.

Only top quality fruit gets the best returns. Rough handling during harvest will result in bruised and damaged fruit. Many of these marks will not show until the fruit is ripened. A few minutes of careless handling can undo months of good work.

Cut fruit early in the day in the summer to avoid handling fruit when it is too hot. In winter fruit that is too cold in the morning may bruise more easily, so don't start too early in the middle of winter.

How to cut

- Nick the stem about $\frac{2}{3}$ up with a cane knife.
- The stem should then bend over ready for harvest without snapping, but be wary as some stools may be brittle and snap.
- A shoulder pad is needed to reduce damage to the fruit – cut the bunch directly onto the shoulder. Do not allow the bunch to be placed on ground.
- Use an A-frame on your vehicle with good clean padding on the frame, and have extra padding to go between bunches. Securely tie bunches to the frame. Anything less can undermine the quality of your packed fruit.

- Make sure you drive on well-maintained roads with a well-sprung vehicle. Every bump is causing damage to fruit.
- Minimise the time fruit spends in the sun between cutting and unloading at the shed by:
 - parking in the shade while cutting and loading
 - covering the load with a pad whilst cutting more fruit
 - at the shed, park the vehicle in the shade while unloading
 - putting a tarp over the load is **not** a good option, as heat builds up under it
 - using shade cloth over the load will reduce heat build-up.



Using different coloured bags each month makes harvesting more efficient.

IN THE SHED – PRESENTATION PAYS IN THE MARKETS

Fruit which is well packed and of uniform and reliable quality gets the best returns in the markets. Much time and effort was spent getting a good quality product to the packing shed. Careful handling and consistent packing will give the best returns. Damage done to fruit in the shed may not show up until after the fruit is ripened but will adversely affect your returns and your reputation in the market.

Unload and dehand with care

There are a range of systems used to handle fruit in the packing shed. Whatever system is used it must minimise handling of the bunches. Every time the bunch supports its own weight or leans against other bunches some fruit gets damaged – even if you can't see the bruises immediately.

Best option

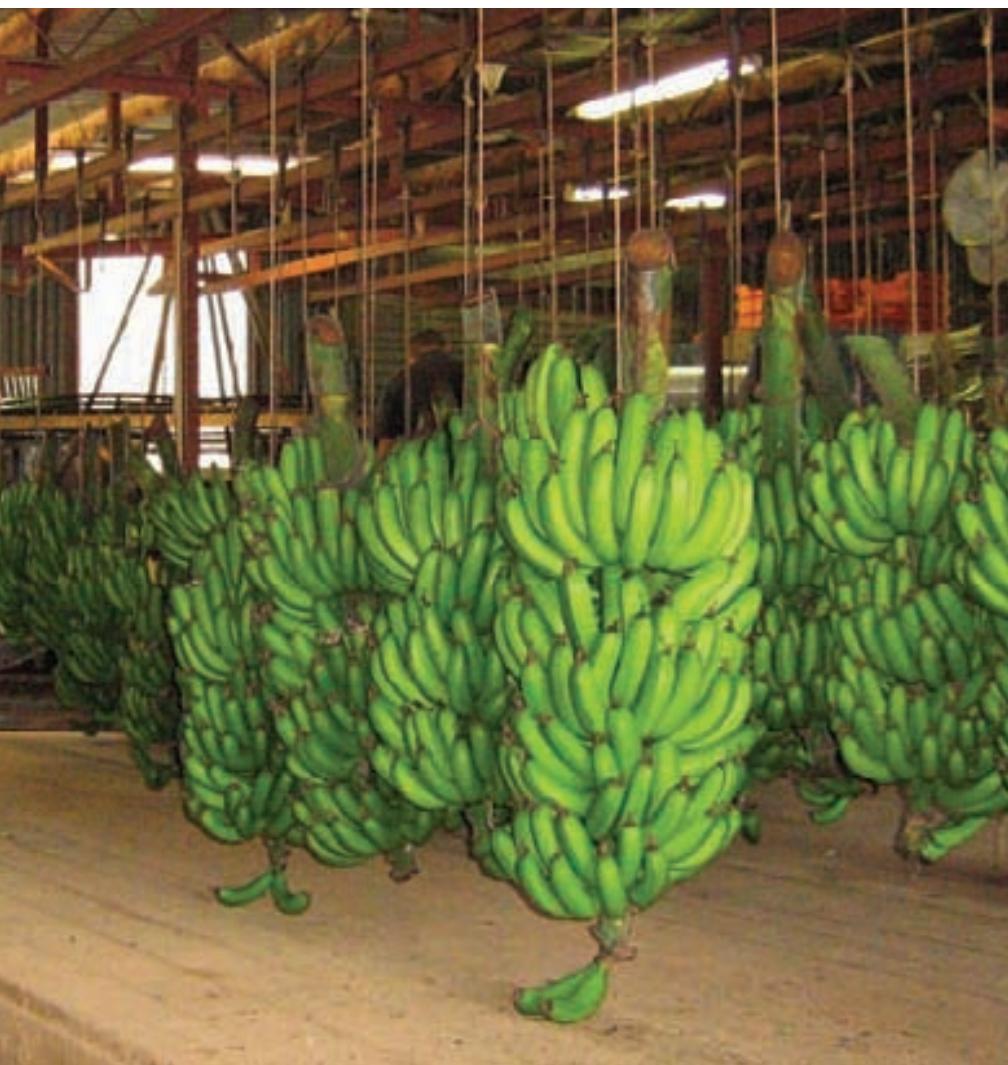
Butchers rails – fruit is unloaded and hung onto the rails. Bunches are kept apart, the bunch cover is removed to allow field heat to escape and the bunch is sprayed/washed with water to aid cooling and remove any dust or bits of leaf or flower ends.

Second best option

Dehanding one bunch at a time

– unload one bunch at a time and dehand immediately into a bath or onto a packing wheel – do not unload, stack and dehand later, it is double handling and increases fruit damage.

- Using a bath – dehand directly into clean water and cluster fruit at this stage if required. Replace water regularly before it becomes sappy. Once sap flow has ceased place fruit gently on the wheel or bench.
- Using a packing wheel – put fruit on the wheel and hose or spray with water until the sap stops flowing. Wheels are the best option as they cause less damage to the fruit, allow the fruit to drain better and take up less room.
- Use fans above the packing wheel or bench to cool fruit when necessary. Never stack hands on top of each other.



Bunches hanging on butcher rails ready for dehanding onto a packing wheel.

IN THE SHED – PRESENTATION PAYS IN THE MARKETS

Packing tips

Know your market

It is important to know what your merchant wants. When packing fruit reject any fruit that does not meet your merchant's standards during dehanding. This includes fruit with blemishes, misshapen fruit, split or damaged fruit and doubles. Any bunches with mixed ripe fruit should be discarded and no fruit from that bunch packed for market. Fruit going to the southern states or Western Australia needs to be inspected for compliance with ICA-16 at this stage.

Pack clean dry fruit

Let fruit drain until there is no obvious water on the skin and apply stickers if required. Aim to have the same quality standards all year round. It is advisable to have a range of packing options to suit the differences in fruit size and quality at different times of the year, such as packing in hands or clusters.

Use strong cartons

Do not use cheap, poor quality cartons. Use high quality cartons so the carton can support the weight of the fruit. The carton must remain strong and not collapse under the high humidity of modern ripening rooms. Saving a few cents on lower grade cartons will cost you dollars in the market.

Pack to avoid marks on fruit

When packing try to avoid the wood on the cluster from coming into contact with the skin of other fruit. Above all aim to meet your merchant's preferences regarding pack style and inserts like plastic sheets and absorption pads etc, and talk to them regularly to get feedback on your fruit and make sure you keep up with the market.

Visit the market at least every 12 months. By doing this you will get to know your merchant and be able to see how your fruit looks when it comes out of the ripening room. Do this at different times of the year so you can see if there is any difference in your fruit during different months.

During packing do not:

- mix stale fruit with fresh glossy fruit
- pack curly hands with straight hands
- pack November dumps with other fruit
- mix grades in the same carton
- mix fruit of different maturity in the same carton
- mix fruit of different ages in the same carton
- ‘top’ your carton (hide poor quality fruit in the bottom of the carton).



This fruit has been washed and clustered ready for packing.

IN THE SHED – PRESENTATION PAYS IN THE MARKETS

Keep the fruit cool after packing

Keep the shed cool with insulation, ventilation and shade where possible.

If possible stack packed cartons directly onto pallets or the back of the transport vehicle on the shady side of the shed. When stacking the cartons onto pallets, column stack the first three layers so it is the cartons, not the fruit that carry the weight.

Aim to get the cartons into a loading centre cool room on the same day as cutting.

Keep records as required

Don't forget to keep records as needed, for your own production records, for ICA-16 compliance and records for your Freshcare® food safety system.

Keep the shed clean

Don't forget you are handling someone's food, so keep the packing shed hygienic to avoid contamination of fruit.

Points to help improve packing shed hygiene

- Clean the packing shed after each day's packing.
- Place all rubbish in designated bins and dispose of well away from the packing shed at the end of the day's packing.
- Dispose of stalks and discarded fruit well away from the packing shed. Do not return stalks to the plantation as this can spread Panama disease.

- Have toilet and hand washing facilities available for you and your staff.
- Carry out a regular rodent control program in the shed.
- Exclude all animals from the packing shed.
- If pesticides are stored in the shed keep them in a designated area away from fruit handling areas.

Transport your fruit carefully

Fruit should be handled carefully all the way through the market chain. Fruit on pallets always gets a smoother ride than fruit handled as cartons. If you use a carrier, make sure the truck is clean and the carrier looks after the fruit as well as you do.



Packed bananas in the coolroom ready for transport to market.

SUSTAINABLE BANANA PRODUCTION – LOOKING AFTER YOUR FARM

As well as producing a quality crop of bananas you need to spend some time looking after the long term viability of the farm to ensure the plantation will be as productive in the future as it is now. There are a range of good practices that growers have developed which can improve the farm's long term health. These practices are focussed on the fundamental needs of a productive farm, such as healthy soils, well managed pest control, and efficient use of water. Many of these practices have been covered in other parts of the guide, and are summarised here.

Healthy soils

- While it may be hard to write a formula for healthy soils, there are some practices that successful growers have used which are likely to contribute to the health of their farm's soils and sustained production.
- Protect soil from erosion with cover crops. This is very important during clearing and establishment, and remains important in older plantations. Even retaining a strip of grass or low-growing weeds less than 30 cm high between rows can do a lot to help.

- Have well planned roads, with banks and drainage areas protected by cover crops to guard against washouts. Use natural drainage lines if possible, and keep them vegetated.
- Protect soils from acidification – use fertiliser types that have low acidification potential and apply fine lime when corrective action is needed. Some nitrogen fertilisers are quite acidifying, with sulfate of ammonia being the worst.
- Apply fertiliser in small amounts often rather than in a few big applications each year. Broadcast fertiliser rather than banding above the stools; this will guard against salinity build up in the soil.
- Maintain soil organic matter – the residual banana plants themselves are a good source of organic matter, but the roots of desirable cover crop plants in particular are also very valuable in building and maintaining organic matter which helps bind the soil together.
- Avoid applications of pesticides to the soil except when they are essential (there are methods of weevil borer treatments that do not require soil treatment).

Integrated pest management

Integrated pest management (IPM) might sound complicated, but many growers are already doing it for some pests. IPM comes down to understanding the pest's habits, monitoring for their presence and using a range of methods to keep the pest population below economically damaging numbers. Relying on calendar based treatment schedules is often a waste of time.

For example, IPM for leaf disease simply involves reducing the disease load in the plantation by green deleafing, removing excess suckers to facilitate air movement and then using strategic leaf sprays when the weather conditions indicate treatment is needed. It also involves rotation of fungicides to avoid developing selections of the disease organisms that are able to tolerate the fungicide.

Another example is banana weevil borer control, using plantation hygiene to reduce weevil breeding sites (i.e. splitting stem material so it dries out), monitoring to decide when treatments are needed, and treatments such as residual plant injection that allow beneficial insects to survive and further help control the weevils.

The advantages of this approach are that it often reduces costs of control and helps to ensure that valuable pesticides are protected from resistance. It also allows beneficial predators to build up in the plantation that may otherwise be killed off.

SUSTAINABLE BANANA PRODUCTION – LOOKING AFTER YOUR FARM

Water usage

Irrigation is definitely an asset in banana production and a well managed and maintained irrigation system will maximise these benefits. The efficiency of the irrigation system used and the scheduling of irrigation in response to measured soil moisture levels are two areas that can greatly influence water use efficiency. More specialised information is available for irrigators through the nearest office of NSW Department of Primary Industries.

Windbreaks and other vegetation

Most banana plantations will benefit from having windbreaks on the southern or south-western boundaries. Vegetation is also useful to stop erosion in the gullies and to provide habitat for wildlife.

Environmental management systems

Segments of the market are beginning to demand assurance that crops are grown in a production system that has minimum environmental impact. While many growers carry out good

practices and make decisions based on the long term sustainability of the farm, it is likely that markets will require some formalised assessment of farming practices in the future. It will become important to ensure the industry as a whole is achieving a good standard and systematic approaches will be encouraged. Environmental management systems (EMS) such as the Freshcare® environmental assurance program are encouraged by NSW DPI, and are likely to be favoured in the market place. While there are several programs available to growers at present, there are no formal requirements as yet.



The strip of native vegetation protects this plantation from cold southerly winds.

MEETING MARKET ACCESS REQUIREMENTS

Market access requirements

An ICA-16 certification or a plant health certificate is required to send fruit to Victoria, Tasmania, South Australia and Western Australia where Queensland fruit fly is of concern. Contact NSW DPI for more information on certification.

Food safety accreditation

Growers need a food safety assurance scheme in place to sell fruit to major retailers. The food safety system will outline steps which prevent contamination of fruit and ensure it is fit for consumption.

The widely recognised Freshcare® system will satisfy the food safety certification requirements of banana merchants in all Australian markets.

FURTHER READING

Banana Growing Basics for New South Wales, Newley P, Akehurst A, Campbell B and Treverrow N. NSW Department of Primary Industries, May 2008.

www.dpi.nsw.gov.au/agriculture/horticulture/tropical/bananas/growing-basics

Soil & Water Best Management Practices for NSW Banana Growers, Akehurst A, Newley P and Hickey M. NSW Department of Primary Industries, June 2008.

www.dpi.nsw.gov.au/agriculture/horticulture/tropical/bananas/soil-water-management

For other titles about growing bananas go to www.dpi.nsw.gov.au

Also see the following websites:

Australian Banana Growers Council at www.abgc.org.au

Horticulture Australia Limited at www.horticulture.com.au

Freshcare® at www.freshcare.com.au



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

