Freshcare

Environmental
Edition 3

Banana Cultivation Requirements for

Queensland Reef Protection Regulations

(Ref 2021.01)

www.freshcare.com.au

Overview

The aim of this document is to provide guidance to implementing the additional requirements of the Freshcare Environmental Standard (Code of Practice) Edition 3 in relation to Queensland Reef protection regulations for Queensland Banana producers.

Freshcare and the Australian Banana Growers' Council (ABGC) have been working with the Queensland Government Office of Great Barrier Reef to gain program recognition of the Freshcare Environmental Program (ENV3) under *Part 5A of the Environmental Protection Act 1994 (Great Barrier Reef Protection Measures) (EP Act)* for agricultural environmentally relevant activities (Ag ERAs), namely commercial banana cultivation.

Program recognition supports Freshcare Environmental certified participants to be recognised for the systems they already have in place that are verified by third-party audits and are therefore a lower priority for compliance activities undertaken by the Department.

The *Reef Protection Regulations* established by the Queensland Government to protect the Great Barrier Reef apply to all banana producers in Reef catchments: Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary regions. The required date of implementation varies.

As an recognised program Freshcare Environmental audits Banana producers in the specified regions, an alternative pathway to demonstrating/verifying compliance by banana producers with the minimum practice agricultural standards and record keeping requirements under the Reef protection regulation under Freshcare ENV3.

Under the Reef protection regulations, all banana producers in the Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary regions will be required to:

- keep general records from **1 December 2019**, for example about fertilisers applied to land
- comply with minimum practice agricultural standards as this requirement is applied to each region over the next three years from December 2020.
- obtain an environmental authority (permit) if commencing new or expanded cropping or horticulture activities on five hectares or more that do not meet the cropping history test in the Cape York, Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary regions from **1 June 2021 (deferred from 1 June 2020).**

Links between the Banana BMP and the Freshcare Environmental Standard

The Banana Best Management Practice (BMP) Guidelines were developed in 2013 as a joint initiative of the Australian Banana Growers Council (ABGC), the Queensland Government Department of Agriculture and Fisheries (DAF) and Hort Innovation. The original BMP was developed by growers, as a tool for self-assessment of their own environmental practice against the wider industry.

ABGC developed the Banana Best Management Practice (Banana BMP) Environmental Guidelines for the Australian Banana Industry, to help growers self-assess their own environmental practices against the wider industry, including an assessment of nutrient management practices on farm. Generally, growers are supported by an ABGC Extension Officer to complete the checklist the first time and then are encouraged to re-assess annually thereafter.

The current Banana BMP project (Phase 2): *Improving knowledge and farming practices of North Queensland banana growers to achieve better water quality on the Great Barrier Reef* is funded by the Queensland Government's Reef Water Quality Program and delivered by ABGC. This project includes a requirement that an accreditation scheme/ package for banana growers is developed by ABGC and endorsed by the Office of the Great Barrier Reef. The accreditation scheme for banana growers is achieved in partnership with Freshcare Limited.

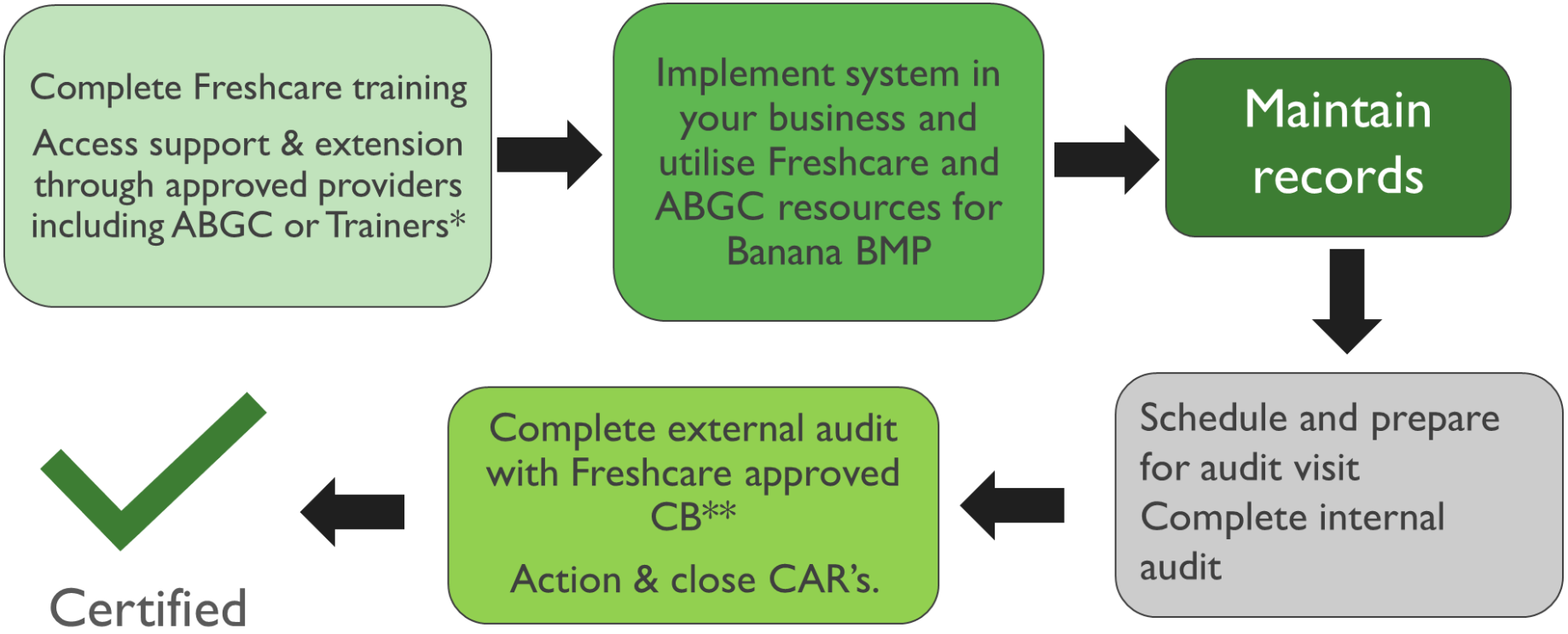
The Reef protection regulations reflect industry practice in the areas of record keeping, nutrient usage and sediment management.

The Banana BMP aligns with the Freshcare Environmental Standard Edition 3 (Code of Practice) (ENV3) and this material provides participating businesses a comprehensive document to support the implementation of specific requirements to demonstrate compliance at audit.

- Growers are encouraged to complete the Banana BMP self-assessment checklist and management plan as part of their Freshcare Environmental Action Plan (EAP, E1) and demonstrate continuous improvement.
- The Banana BMP Self-assessment (Banana BMP Program) can be used as an input to the EAP, for identifying areas where improvement activities need to be implemented. The completion of the self assessment checklist can be used as evidence for compliance of E1.1.1.
- Under the minimum practice agricultural standard, the producers who implement and self-assess using the Banana BMP checklist can utilise the outcome of the BMP self-assessment to demonstrate compliance to the applicable elements of the Freshcare Environmental (ENV3) Standard. This checklist can be provided at audit in addition to the M4 Internal Audit record to demonstrate both compliance to the industry Standard and Legislation.

For more information on the Banana Environmental BMP refer to the Australian Banana Growers' Council website: abgc.org.au/environmental-bmp

Information on the Integration of BMP and Certification Standards



*** Freshcare approved trainers: www.freshcare.com.au/training/trainers/**

**** Freshcare approved certification bodies (CB's): www.freshcare.com.au/auditing-and-certification/certification-bodies/**

Best Management Practices (BMPs)	Management Systems – Standards/Certification Programs
• Best Management Practices (BMPs) provide specific techniques, operational practices and industry guidelines for establishing, achieving and reviewing best production methods and management of resources within a business/industry. • BMPs can be industry, commodity or regionally specific. • BMPs provide information about suggested management practices based on research and development and current industry best practices. • BMPs provide resources that may be specific to regional conditions, an industry or commodity. • BMPs provide a method for businesses to self-review their existing practices. • Implementation of BMPs, are often a business's first step towards achieving formal Certification to a recognised Program/Standard.	• Standards and Certification Programs provide specific requirements via a management systems approach for businesses to implement in order to demonstrate that their operations are consistent and comply with the outlined requirements. • Standards and Certification Programs are often based on BMP guidelines, developed to provide a framework for businesses to achieve recognised compliance. • Certification to a Program/Standard is achieved through an independent (third-party) audit. • Standards and Certification Programs provide a method for businesses to formally review and continually improve their practices. • Certification to a Program/Standard provides formal recognition of a business's achievement. • Certification to a recognised Program/Standard provides independent verification to suppliers, customers and other interested parties.

Additional information and resources:

Freshcare Factsheets and Forms: www.freshcare.com.au/resources/reef-bananas
including Factsheet E2 - Land and soil management for banana cultivation; and Factsheet E5 - Nutrient management for banana cultivation).

Australian Banana Growers Council – Banana BMP and environmental resources: abgc.org.au/environmental-bmp

Queensland's Reef protection regulations and minimum practice agricultural standards: www.qld.gov.au/environment/agriculture/sustainable-farming/reef/reef-regulations/producers/bananas

The agricultural environmentally relevant activity (Ag ERA) standard for banana cultivation: www.qld.gov.au/__data/assets/pdf_file/0013/113143/banana-era-standard.pdf

Factsheet – E2 (insert) Land and soil management for Banana cultivation

This factsheet covers:

- **Best Management Practice - Bananas**
- **Managing land and soil**
- **Soil structure management and remediation**
- **Soil erosion management and remediation**
- **Salinity management and remediation**
- **Soil acidity management and remediation**
- **Sodicity management and remediation**
- **Management of contaminated soils**
- **Additional resources**

The following resources may assist with land and soil management priorities:

- Australian Soil Resource Information System: www.asris.csiro.au
  Providing access to key sets of Australian soil information.
- Australian Collaborative Land Evaluation System: www.clw.csiro.au/aclep/
  Providing information on soil and land resources.
- Climate Kelpie: www.climatekelpie.com.au or Bureau of Meteorology: www.bom.gov.au/providing climate information.
- The Australian Banana Growers' Council: www.abgc.org.au

Best Management Practice - Bananas

The Australian Banana Growers Council developed the Banana Best Management Practice (Banana BMP) Environmental Guidelines for the Australian Banana Industry, to help growers self-assess their own environmental practices against the wider industry, including an assessment of their land and soil management.

The Banana BMP aligns with Queensland Reef protection regulations and the Freshcare Environmental Standard Edition 3 (Code of Practice) (ENV3).

Growers are encouraged to complete the Banana BMP self-assessment checklist and management plan as part of their Freshcare Environmental Action Plan, continuous improvement cycle.

For more information on the Banana Environmental BMP refer to the Australian Banana Growers' Council website: abgc.org.au/environmental-bmp

Managing land and soil

Healthy, productive soils are essential for farming. Businesses should always implement practices that maintain or improve soil condition. The priorities for soil management vary depending on soil types, topography of the land, surrounding environment, previous land use and climate.

Soils are classified into a range of soil classes. Bananas grown in better class soils have higher yields and are more profitable. Bananas prefer soils that are not prone to water logging. They should be free-draining, have good internal structure and be suitable for cultivation. It is important to understand the soil types on your farm, their characteristics and the best way to manage them.

Soil structure management and remediation

Select farming practices that will maintain or improve soil structure to ensure optimal productivity. Potential ways to manage or remediate soil structure are provided under sub-headings in this section.

Crop Rotation

Planting a fallow crop in between each banana crop rotation helps to maintain or improve the soil structure. In any fallow period, it is important to kill volunteer bananas as they can harbour pests and diseases from one crop rotation to the next. The longer the block can be left fallow, the better for soil health. Ideally, blocks should be left with a fallow crop for a minimum of 12 months.

A break in production by introducing a fallow crop is important and can provide the following:

- **Banana pest control** – introducing a crop that is not a host for pests such as banana weevil borer or plant-parasitic nematodes, breaks the pest life cycle, effectively removing them from the block.

- **Soil biology** – introducing a new crop encourages a diversity of microorganisms and maintains an environment that is conducive to growth, as an active root system is required for a healthy food web.
- **Organic matter** – incorporating fallow crops into the crop rotation helps to improve soil organic matter levels.
- **Erosion protection** – a fallow crop provides ground cover and protection against the impacts of rainfall and surface water runoff.
- **Compliance with regulation** – if you are in a reef catchment area, you must maintain adequate covered ground during the fallow period.

Selecting the fallow crop in a banana rotation depends largely on two factors:

- the presence or absence of plant-parasitic nematodes.
- the length of time the block will be left fallow.

If plant-parasitic nematodes are present, it is important to identify which nematodes cause the main economic problem and select a fallow crop that is not also a host.

If plant-parasitic nematodes are not present, select the fallow crop by simply choosing a crop that suits the climatic conditions and will provide maximum organic matter:

- In the tropics, suitable crops are sorghum and rhodes grasses.
- In the east coast subtropics, molasses grass, lotononis and broadleaf paspalum are suitable.
- In the west coast subtropics, crops such as sorghum are also suitable, but will need irrigation.

If a fallow crop cannot be planted, volunteer grass or a weedy fallow is preferable to a bare fallow as it will still protect the soil from erosion and provide an active root zone for microorganisms. Bear in mind, however, that it could continue to host plant-parasitic nematodes, if they are present.

The Queensland Reef protection regulations prescribes that at fallow, **all** blocks must have a grassy fallow or cover crop established that maintains adequate covered ground.

Increasing organic matter

Organic matter is an essential component of a healthy soil because it increases the soil's nutrient and water holding capacity, improves the soil structure and provides a food source for soil organisms. It can be difficult to increase the amount of organic matter because it decomposes rapidly in the warm climate of most banana production areas.

Increased organic matter can be achieved by implementing the following practices:

- Growing fallow crops in between banana crop rotations.
- Applying compost and manures.
- Applying sugar cane by-products such as mill mud NOTE: Mill mud has the potential to introduce pests, diseases and weeds.
- Returning harvested stems and leaves to the row.
- Using a side-throw slasher to put the vegetation slashed from the inter-row onto the rows.
- Applying mulch.
- Reducing cultivation.
- Avoiding high rates of nitrogen fertiliser.
- Encouraging earthworm activity, which incorporates organic material deeper into the soil.

Cultivation method and timing

For most of the banana industry in Australia, mechanical cultivation is essential.

While cultivation prepares the bed for planting and removes any potential compaction zones, it leaves the soil exposed to erosion.

Too much cultivation or poor cultivation techniques can be detrimental to the soil structure. This can lead to surface crusting and loss of air spaces preventing water, air and root access. Fertility may be reduced, if less fertile subsoil is being brought to the surface.

Several things should be considered to improve cultivation outcomes including:

Factsheet – E2 (insert) Land and soil management for Banana cultivation

- **Cultivation timing** - cultivate at times of the year when there is a lower risk of rainfall to minimise the chance of erosion.
- **Minimal tillage - r**educe the impact of cultivation by minimising the number of passes, which will conserve the soil structure.
- **Cultivate at the correct moisture level -** soil should not be worked when too wet or too dry. If the soil is too wet, it can cause large clods and compaction below the cultivation zone. Too dry, and the soil can be pulverised into a fine dust, losing structure and potentially causing surface crusting or wind erosion.
- **Maintain the same row location (permanent beds)** - if the irrigation system does not need to be moved, plant successive crops back into the same row. The frequency of mechanical operations such as bagging, picking and spraying in a banana plantation means that a lot of traffic travels each banana row. Over time, this soil can become very compacted. Marking the rows on a GPS provides the opportunity to plant back into the original row configuration. This avoids planting into the compacted inter-row regions.
- **Permanent beds** - consider switching to a permanent bed system. As long as drainage is adequate, there is no real need to work up the inter-row space. This effectively means only half the block is being cultivated.
- **Pre-forming beds** - form beds at the time of year when heavy rainfall is least likely, and sow with a cover crop. The benefits of this approach include good soil cover during wet periods and mounded rows dry the bed out more quickly. This gives more flexibility in planting times, as minimal cultivation is then required to prepare for planting.
- **Crop removal** - consider eradicating the old banana crop by injecting with glyphosate rather than cultivating. Control volunteer bananas with herbicide rather than cultivation.

Improvement activities to increase ground cover, soil structure and soil organic matter should be documented in your Environmental Action Plan (EAP), for more information refer to *Freshcare Factsheet E1: Environmental action planning*.

Soil erosion management and remediation

Managing soil erosion is especially important in the subtropics on the east coast, where bananas are grown on relatively steep gradients, and in the tropics of Far North Queensland, where significant, high intensity rainfall is received.

The west coast subtropics are also vulnerable to wind erosion and water erosion during flooding events.

Under the Queensland Reef protection regulations, banana growing activities should minimise sediment loss to waterways by having appropriate erosion and sediment control measures in places where there is a high risk of soil loss from the farm.

There are two main principles for managing soil erosion:

- Maintaining ground cover.
- Controlling runoff water.

Ground cover

Good ground cover is essential for managing soil erosion. Ground cover can provide the following benefits:

- Intercepts rainfall, reducing the surface impact of raindrops.
- Slows the velocity of surface water.
- Increases water infiltration.
- Stabilises the soil.

A suitable ground cover is:

- Shade tolerant.
- Not invasive or too competitive.
- Perennial.
- Tolerant of traffic (tropical production or row configuration plantings).
- Short growing and has a spreading habit.
- A non-host for the main plant-parasitic nematodes if they are present.

Factsheet – E2 (insert) Land and soil management for Banana cultivation

Maintain a minimum 60% ground cover

While a living ground cover is preferable, a dead cover can also provide protection from erosion. If spraying the inter-row cannot be avoided, allow the vegetation to grow and then spray with a knock-down herbicide. This will preserve the root system and provide a mulch layer to protect the soil. Regardless of whether it is living or dead, a minimum of 60% ground cover is required.

Under the Queensland Reef protection regulations all blocks must have adequate covered ground at appropriate times in the banana crop cycle.

- Inter-rows on plant blocks have **at least 60%** covered ground before 1 November (wet season) (unless undertaking renovation works).
- Inter-rows on ratoon blocks have **at least 60%** covered ground (unless undertaking renovation works).

There are several ways to maintain and promote ground cover in the plantation, as provided under sub-headings in this section.

Promote vegetation around the farm

Maintain vegetation and slash rather than spraying it out, especially during periods when there is a high risk of erosion. If it is not possible to maintain slashed inter-rows and headlands across the farm all year round, ground cover should be a priority:

- In plant blocks.
- During the wet/storm season.
- On steeper slopes.
- On lighter soils that are prone to erosion.

Mulching the inter-row space

In drier climates, where organic matter decays more slowly, mulching trash material in the inter-row space provides an effective ground cover and contributes to the required 60% coverage (if in a reef catchment area).

Mulching on the row

Where cultivation is limited, establish a fallow grass crop and then spray this out before planting, leaving a mulch layer over the ground. Other, low-growing cover crops may only require spraying in the immediate row area where the banana is to be planted. In the tropics, use a side-throw slasher to put mulch on the row.

Good drainage in paddocks

Paddocks that drain well are less likely to become water logged and boggy and will maintain a better ground cover.

Wider row spacing

Adopting a wider row spacing allows more sunlight to reach the ground which will help with better ground cover.

Reduce traffic in the rows

Keep out of new paddocks to allow them to establish and reduce traffic when its wet.

Companion crops

Planting a quick establishing companion crop is recommended for plant crops or bare ground, especially during high risk rainfall periods. In the east coast subtropics, white clover and summer grass are suitable.

Place leaves and harvested heads on the row

This provides soil cover and prevents the inter-row grasses from being smothered.

Plan the timing of crop removal and cultivation

Plan banana crop removal and general cultivation activities for the time of year when there is the lowest risk of rainfall. Time the inter-row maintenance for the dry times of the year.

Factsheet – E2 (insert) Land and soil management for Banana cultivation

Eradicate the old banana crop by injecting

Remove the old banana crop by injecting with glyphosate rather than cultivating. Also, control volunteer bananas with herbicide rather than cultivation.

Ensure ground cover is maintained during other farming activities

Maintain ground cover on buffers/headlands between the blocks and creeks or drains. For example, maintain the ground cover when installing a pump near a creek bank.

Controlling runoff water

Controlling the speed and direction of runoff water is critical for minimising erosion. Measures and structures should be introduced to slow water where slopes are likely to produce high velocity water flows. Surface water should be directed to suitable waterways that are capable of carrying high velocity water.

Under the Queensland Reef protection regulations banana producers are required to minimise sediment loss to waterways by having appropriate erosion and sediment control measures in places where there is a high risk of soil loss from the farm.

For more information on the minimum agricultural standards under Queensland's Reef Protection Regulations, refer to the Qld Government website: www.qld.gov.au/environment/agriculture/sustainable-farming/reef/reef-regulations/producers/bananas

Or, the agricultural environmentally relevant activity standard for banana cultivation: www.qld.gov.au/__data/assets/pdf_file/0013/113143/banana-era-standard.pdf

The following information provides measures that may be implemented on your farm to reduce sediment run-off.

Not all measures would be suitable for your property and it is recommended that you seek professional advice in particular where the topography makes the soil more prone to erosion.

Farm design

Use farm maps and topographical maps to design or improve the farm layout, to provide permanent, all-weather access and good drainage. These plans need to take into account soil types, current and future land use, gradients, existing waterways and irrigation layouts.

Block selection

Avoid growing bananas in low-lying areas that may be prone to flooding, especially where high velocity flooding occurs and on steep slopes where erosion cannot be managed.

Block design

Use structures such as diversion banks, contour banks and constructed waterways to manage the direction and velocity of surface water. Engage a consultant to help plan where to place these structures.

- **Contouring** - as a general rule, any land with a gradient greater than 3% (a 3 metre fall in 100 metres) should be contoured. Contouring stops water running off slopes too fast and subsequently eroding soil. Seek professional advice before developing contours. Unless major modifications are required, maintain these rows as permanent beds.
- **Diversion banks** - these are often used to catch surface water from above a paddock, diverting it away from the block and into a suitable waterway.
- **Constructed waterways** - these are wide, vegetated, flat-bottomed structures designed to collect runoff and slow the water before conveying it at a safe velocity to a drainage line or natural waterway. They are often called a spoon drain. They differ from constructed wetlands, which are planted with vegetation to capture and hold runoff water (for at least two days), allowing time for fine sediments and nutrients to be removed from the water. The drain should be wide and shallow to slow run-off, with gentle sloping banks to prevent slumping or bank erosion, allowing coarse and medium sized sediments to settle. The spoon drain may require occasional sediment removal or maintenance to ensure discharge capacity is maintained. You should re-

establish vegetated cover (e.g. grass) immediately following any maintenance works.

- **Silt traps** - these are structures that cause suspended sediment in run-off water to be collected and detained, allowing the medium to coarse sediments to settle within the trap. The silt trap will require ongoing maintenance to ensure its effectiveness. These are a last line of defence against sediment leaving your farm and are not effective on their own. Excess sediment in the silt trap demonstrates that the farming system is failing elsewhere. Professional advice on the design and positioning of silt traps will save time and money, while ensuring the desired impact.
- **Laser levelling** - on farms with little gradient, blocks should be laser levelled, where practical and affordable, to ensure a constant fall and prevent water from collecting in the paddock and creating wet areas. Afterwards leave blocks to consolidate as long as possible before planting and consider forming beds early, then planting with a cover crop.
- **Vegetative ground cover -** maintaining grass or vegetation cover wherever possible on the farm helps to stabilise the soil, reduce the velocity of surface water and provides filtration before the water leaves the farm. Living or dead vegetative ground cover contributes to the minimum standards required under reef protection regulations.
- **Land clearing -** do not clear vegetation from steep land where soil conservation practices cannot manage potential erosion problems. Each state has different land clearing legislation. Clearing native vegetation is regulated by both Commonwealth and State Government departments, contact your state natural resource department to get the necessary permits before clearing land.

Plant crop

The plant crop stage is the most susceptible to erosion and should receive the most care and attention for the following reasons:

- The soil has not yet consolidated following recent cultivation.
- There is limited ground cover as it has not yet established.
- There is limited plant root mass to hold the soil together.
- There is limited plant canopy to intercept rainfall before it hits the ground.
- There is limited banana 'trash' to provide ground cover.

Planting a rapidly establishing companion crop is recommended for plant crops or bare ground, especially during high-risk rainfall periods.

Under the Queensland Reef protection regulations, by the start of the wet season all plant blocks must have **at least 60%** covered ground in the inter-row, except when undertaking renovation works (for example, to remove wheel ruts).

In a system where cultivation is not required before planting, (such as a pre-formed bed system or in plantations established by hand-planting), an effective management strategy is to establish a fallow crop and spray this out before planting. This will provide a thick mulch layer that will cover the soil. Care is needed because this mulch layer may harbour plant pests and diseases such as bacterial corm rot (*Erwinia*).

Drains

- Use pipes and culverts to reduce the need for machinery to drive across drains and put rocks on those where access cannot be avoided.
- Natural gullies and waterways should not be disturbed or redirected.
- Consider installing a diversion drain at the top of a sloping block to keep the water out of the block altogether.
- Broad, shallow spoon drains are most suitable as they are less susceptible to erosion and allow vegetation to be easily maintained with slashing. This is particularly important on lighter soils.
- Use 'drop structures' in drains where there is a significant fall to reduce water velocity and therefore subsequent erosion.
- Maintain living vegetation on drains during the wettest periods of the year.
- Slash rather than spray drains or, if spraying, let the grass at the side of the drain get tall before spraying with a knock-down herbicide. This will

preserve the root structure of the plants and protect the bank with a mulch layer.
- Inspect drains regularly, especially during heavy rainfall, to ensure they are working effectively.
- Carry out drain maintenance during the low risk rainfall periods.
- Stabilise drains with coarse aggregate/ballast where necessary.

Roads

The roadway should never be used as a drain unless it has been specifically constructed and stabilised for this purpose. The roadway may only be used to help direct water to an appropriate drainage line as long as they were constructed for this purpose.

- Stabilise main headlands with sand and rock, as they pack hard. Remove wheel ruts and repair roadways as necessary.
- Put a suitable batter on 'built up' roads to prevent erosion from the sides of the road, and maintain vegetation beside the road batter.
- In steeper areas, for example on the subtropics east coast, concrete the roads that receive a lot of traffic and the corners where vehicles are constantly turning and disturbing the soil.
- Use pipes/culverts under the road, where necessary, to prevent water from damming. This ensures good drainage so that water does not pond in traffic areas.
- Build roads on the contour or build whoa-boys or inverts to allow water to cross the road.

Inter-rows

- Encourage traffic to stay on the roadways/headlands instead of taking short-cuts through paddocks.
- Make the main picking rows wider to allow extra sunlight and air flow, which enables them to dry out more quickly and makes conditions more conducive for vegetative ground cover to grow. It will also mean that less damage is caused to the fruit hanging in the picking row during harvest.
- Maintain grass in the inter-row space. Vegetation will reduce the raindrop impact (splash erosion), increase water infiltration, decrease the speed of surface-water runoff, reduce soil movement with machinery and improve the soil structure.
- Where necessary, use a 'V' blade to make the centre of the inter-row the lowest point, rather than the wheel tracks.
- Repair wet areas in inter-row spaces as soon as possible either with coarse aggregate/ballast or by improving the drainage. Once ruts are established in a block, they are hard to manage and can potentially cause sediment loss in surface runoff water.
- Consider switching to a permanent bed system.

Creeks

- Leave riparian vegetation along the creek/river banks.
- Revegetate and/or stabilise eroding creek banks where significant erosion is evident.
- Avoid constructing roads or tracks through creeks that would affect hydrology and fish passage and that can lead to erosion.

Contact your local, state-based natural resource department and seek professional advice before conducting any work on waterways or riparian vegetation, including works to prevent stream bank erosion.

For information relating to revegetation, refer to the stream bank planting guidelines and hints available at the Queensland Department of Natural Resources, Mines and Energy website.

Contact your local, state-based fisheries department for works that may interfere with fish passage.

You may also seek professional advice from your relevant River Improvement Trust.

Factsheet – E2 (insert) Land and soil management for Banana cultivation

Salinity management and remediation

Most of Australia's banana production areas are free of salinity problems. However, as the industry seeks new production regions for geographical diversification, this may become a greater issue in the future.

Some regions or particular farms within a region may experience salinity problems related to irrigation water.

Growers irrigating from underground water sources should test their water source and manage accordingly. To reduce the salinity of irrigation water, it may be possible to mix it with a better-quality water supply.

Growers irrigating out of tidal reaches should avoid irrigating at high tide to ensure they are only using fresh water. It is also recommended that the water between high tides is tested to ensure the salinity levels are acceptable.

Soil acidity management and remediation

Soils can be naturally acid or alkaline. Soil pH may also change with irrigation, fertiliser and crop management practices. As soil pH changes, the availability of soil nutrients may also change.

A pH (water) within the range of 6 – 7 is ideal for bananas. Depending on the farming location, this could be higher or lower without intervention. For example, Carnarvon soils are naturally more alkaline (high pH), whereas in the east coast tropics soils are naturally more acidic (low pH). Bananas will grow outside of this range, although the closer the pH is to neutral, the better for production.

- Monitor your soil pH and test it at least annually. Continuity in a declining pH at lower levels in the soil profile may indicate that nitrate from ammonium based fertilisers is being lost in deep drainage or leaching.
- Apply soil amendments based on your soil test results to maintain an optimal pH. This will vary depending on your location (refer to the *Freshcare Factsheet E5 Fertilisers and soil additives* for more information).
- Incorporate pH amending products into the soil before planting.
- In low pH (acidic) conditions, lime and dolomite will help to increase the pH. In higher pH (alkaline) conditions, sulphur and ammonium products will help to reduce the pH level. Professional advice should be sought to test for and correct pH.
- In dry periods when spider mites are causing a problem, the extra dust from lime may provide conditions that increase mite populations. More frequent pest monitoring may be necessary in this case.
- Some fertilisers reduce pH, so the fertiliser program needs to be managed accordingly.
- pH conditions outside the optimum range (too acid or too alkaline) can restrict the availability of micro and macro-nutrients as well as influencing soil microbiology.

Acid sulphate soils

Acid sulphate soils can harm banana production and can have a major impact on farm infrastructure. Acid sulphate soils are formed when seawater or sulphate-rich water mixes, in the absence of oxygen, with land sediments containing iron oxide and organic matter. Acid sulphate soils are commonly found less than 5m above sea level. Mangroves, salt marshes, floodplains, swamps, wetlands, estuaries and brackish or tidal lakes are ideal areas for acid sulphate soil formation.

The presence of acid sulphate soil may not be obvious on the soil surface as it is often buried beneath layers of more recently deposited soils and sediment.

When exposed to air due to drainage or disturbance, these soils produce sulphuric acid which in turn can release toxic quantities of iron, aluminium and heavy metals.

Potential ways to manage or remediate acid sulphate soils

Acid sulphate soils can be associated with areas that are poorly drained or scalded and should not be drained, cleared or exposed without first consulting your local state-based agriculture department. Draining, clearing or exposing the soils in these areas will prevent mobilising the acids and toxic elements in the profile.

Factsheet – E2 (insert) Land and soil management for Banana cultivation

Management strategies can only be successful if based on adequate mapping of the sulphide contents. Soil reactivity and depths to which sulphuric and sulphidic horizons occur, may include:

- Re-flooding trials utilizing existing freshwater, tidal and saline ponds in constructed wetlands and brackish water in a ponding basin.
- Bioremediation trial to re-establish reducing conditions to stop pyrite oxidation by the addition of sulphate-reducing bacteria and various organic wastes.
- Slotting trials using soda lime by-product to treat acidic discharging meteoric water or groundwater leachate.

Sodicity management and remediation

Sodic soils are those where the amount of sodium held on to the clay particles is 6% or more of the total cation exchange capacity. They have an unstable structure and are poor places for plants to grow. Sodic soils are generally not very suitable for banana production and unlikely to be used unless there is no other soil type available. Sodic soils have poor soil structure, which means they are prone to surface crusting or sealing, can have poor water infiltration and low water holding capacity. They are dispersive when wet, which is visible as 'cloudy' water, rather than the soil particles staying together. Drains will be susceptible to erosion if constructed on these dispersive soil types.

Gypsum, deep rooted plants and improving soil organic matter can help to improve the soil structure.

Remediation activities for areas identified on-farm as being highly degraded or eroded should be documented in your Environmental Action Plan (EAP), for more information refer to *Freshcare Factsheet E1: Environmental action planning*.

Management of contaminated soils

Persistent chemicals

Soil contamination occurs from persistent chemicals, old dips, dumps, heavy metals, fuels, oils or hydraulic fluid.

- On a farm map, identify areas that have been contaminated and ensure measures are in place to prevent soil from moving from these sites. Avoid these areas, maintain vegetation to prevent soil movement and if necessary fence or bund the contaminated area.
- Provide bunding or a containment method where products that could cause contamination are used.
- Control erosion on the site to help contain contaminated soil.
- Do not plant bananas in contaminated areas.

Soils can be contaminated by the application of chemicals and fertilisers. Persistent chemicals belonging to the organochlorine (OC) and organophosphate (OP) groups may be present on farms due to past use, dumping or spillage. As well as application to previous crops, 'hot spots' such as old dip sites, disposal or dumping areas, remnant building sites and areas near power poles may have persistent chemical residues present.
How long chemicals remain in the soil will depend on soil type, climatic conditions and how they were used (e.g. cover spray, dip, dump site).

Examples of some persistent chemicals used in agriculture include DDT, Lindane, Chlordane, Aldrin, Endrin, BHC, Heptachlor, Methoxychlor, Hexachlorobenzene and Toxaphene.

Areas used to dip or treat livestock or grow sugar cane, sweet corn, some vegetable crops and orchard crops have the highest risk of being contaminated.

In Australia, a common example of a persistent chemical is dieldrin. Dieldrin is an insecticide that belongs to the OC group. Although dieldrin has been banned from use since the 1980s (along with all organochlorine and organophosphate pesticides), it was once applied routinely as an agricultural, industrial and

domestic insecticide for the control of termites (white ants), household pests, ants and soil insects.

Heavy metals

Heavy metals are the group of metals with a specific gravity of five or higher, meaning they are five or more times heavier than water. Examples are cadmium, lead and mercury. Heavy metals may occur naturally in soil or they can be introduced in small amounts through the use of fertilisers (especially phosphate) and soil additives (such as gypsum and animal manure), and from industrial uses (either past or present).

Cadmium is the heavy metal of most concern to fresh produce. Most cadmium (Cd) occurring naturally in the soil is present at levels of 0.1-1.0 mg Cd/kg of soil, and is in an insoluble form, so uptake by plants is low. Cadmium is mobilised and uptake increases where soils are very sandy, saline or acidic, low in zinc or organic matter and if irrigation water is salty.

Lead can contaminate the site as a result of fumes from nearby heavy vehicle traffic, dumping of old paint or weathering of paint from buildings, and from previous use for storage or discharging of firearms (e.g. rifle range).

Other contaminants

Other soil contaminants include hydraulic fluids, oils and fuel from storage areas and machinery. Ensure oils, fuels and hydraulic fluids are stored so as to prevent contamination of soil or groundwater. Regularly maintain machinery and check hydraulic, oil and fuel lines for leakage.

Managing off-site movement

Soil testing in paddocks or areas assessed as being a risk, can be undertaken to determine whether residues are present or not.

Disturbance of affected sites can lead to erosion and off-site movement of contaminated soils, affecting the surrounding environment and wildlife.

Property managers should aim to minimise soil movement off contaminated sites by:

- Identifying these areas on a property map.
- Maintaining groundcover on contaminated sites.
- Implementing effective soil erosion control strategies for larger cultivated sites (see the section on 'Soil Erosion' for erosion control strategies).
- Fencing off, erecting signage, or preventing access or disturbance to smaller 'hotspot' sites.
- If the contamination is significant, affected soils may need to be removed from the site and disposed of at an appropriate facility.

Remediation activities for areas identified on-farm as being contaminated should be documented in your Environmental Action Plan (EAP), for more information refer to *Freshcare Factsheet E1: Environmental action planning*.

Additional Resources

The following additional resources can provide online information to assist banana growers with land and soil management priorities:

The Australian Banana Growers' Council – Environmental Best Management Practice: abgc.org.au/environmental-bmp/

Queensland's Reef protection regulations - Bananas: www.qld.gov.au/environment/agriculture/sustainable-farming/reef/reef-regulations/producers/bananas

Environmentally Relevant Activity (ERA) Standard for Banana Cultivation: www.qld.gov.au/__data/assets/pdf_file/0013/113143/banana-era-standard.pdf

Australian Soil Resource Information System: www.asris.csiro.au

Providing access to key sets of Australian soil information.

Australian Collaborative Land Evaluation System: www.clw.csiro.au/aclep

Climate Kelpie: www.climatekelpie.com.au

Bureau of Meteorology: www.bom.gov.au

Factsheet – E5 Nutrient management (Banana cultivation)

This factsheet covers:

- **Best Management Practice - Bananas**
- **Fertilisers and soil additives**
- **Nutrient management**
- **Soil and leaf testing**
- **Selecting nutrient types and amounts**
- **Nutrient budgeting and planning**
- **Application of fertilisers and soil additives**
- **Storage of fertilisers and soil additives**
- **Record keeping**
- **Record keeping – Reef catchments**

The following resources may assist with nutrient management priorities:

- Nutrient Management section within the Banana BMP: abgc.org.au/best-management-practice
- Queensland Reef Water Quality Program – Prescribed methodology for banana cultivation: www.qld.gov.au/__data/assets/pdf_file/0015/113145/prescribed-banana-methodology.pdf
- Queensland's Reef protection regulations - Bananas: www.qld.gov.au/environment/agriculture/sustainable-farming/reef/reef-regulations/producers/bananas

Best Management Practice

The Australian Banana Growers' Council developed the Banana Best Management Practice (Banana BMP) Environmental Guidelines for the Australian Banana Industry, to help growers self-assess their own environmental practices against the wider industry, including an assessment of nutrient management practices on farm.

The Banana BMP aligns with Queensland Reef protection regulations and the Freshcare Environmental Standard Edition 3 (Code of Practice) (ENV3).

Growers are encouraged to complete the Banana BMP self-assessment and management plan as part of their Freshcare Environmental Action Plan (EAP), continuous improvement cycle.

For more information on the Banana Environmental BMP refer to the Australian Banana Growers' Council website: abgc.org.au/environmental-bmp

Fertilisers and soil additives

The addition of fertiliser in either organic or inorganic forms is essential for sustainable and productive agriculture. However, incorrectly applied fertilisers can degrade soil, ground water, watercourses and reefs. Good nutrient practices must maintain productivity while preventing or minimising off-target impacts.

Fertilisers may be lost from production areas through:

- Inaccurate application.
- Leaching past the root zone and into groundwater.
- Moving as dissolved nutrients in surface water leaving farm paddocks.
- Attaching to soil sediments and within organic particles in surface water leaving farm paddocks.
- Attaching to wind-eroded soil particles.
- Volatilisation into the atmosphere.

Specific management practices are required for each aspect and an appropriate fertiliser program will account for this.

Due to the close proximity of reefs and the heavy rainfall experienced in the Wet Tropics region; correct fertiliser application is one of the major environmental priorities for farmers in the Tropics.

Under the Queensland Reef protection regulations, the regulated minimum practice agricultural standards aim to deliver significant water quality benefits for

Factsheet – E5 Nutrient management (Banana cultivation)

the Reef, while driving better land management practices for profitable and productive farming.

The correct placement of fertiliser plays a critical role in reducing fertiliser losses in run-off, to the air or through the soil profile. In terms of water quality, phosphorus and nitrogen fertilisers cause the greatest impact on the wider environment.

Phosphorus binds tightly with the soil (sorption) and therefore is primarily lost with sediment movement in the form of erosion.

Nitrogen is generally lost by leaching through the soil profile in the form of nitrates, or through gaseous losses during the processes of volatilisation and denitrification as it does not bind readily with the soil. However, both nitrogen and phosphorus have the potential to be lost with surface water runoff, if heavy rainfall occurs before the fertiliser filters into the soil.

Increased nutrients in waterways causes:

- Eutrophication, where microscopic algae feed in nutrient-enriched water, creating an 'algal bloom'.
- Water weed growth, which reduces the habitat and oxygen available for fish.
- Oxygen depletion, and therefore fish death, because the bacteria breaking down algae use up oxygen in the water and kill other aquatic animals.

Increased nutrients and sediment on reefs cause:

- Increased pressure on coral from out-competing marine plants, algae and marine invertebrates. An example is the crown-of-thorns starfish outbreaks.
- 'Marine snow' from sediment affects light penetration and smothers the surface of coral, disrupting the habitat of coral larvae and breaking their life cycle, which results in major changes to the ecosystem.

To efficiently manage nutrient inputs and prevent environmental harm, it is necessary to determine the amount and type of nutrients to apply for each production site rather than using recipe-type application rates. This is done through soil and/or leaf testing and using the testing results to determine the nutrient requirements of the crop at that time.

Nutrient management

Good nutrient management includes:

- Deciding what nutrients are needed, e.g. budget nutrients removed in the crop versus nutrients added in fertiliser applications.
- Ensuring workers responsible for crop nutrition are competent to make recommendations relevant to the crops under their management.
- Applying fertilisers in the right way.
- Minimising nutrient leaching to groundwater, especially nitrogen, by applying less than normal irrigation after fertiliser application or fertigating with less irrigations than normal.
- Ensuring any in-line fertiliser injection systems have back flow prevention measures.
- Storing fertilisers properly.
- Reducing possible harm to the environment by ensuring broadcast application of fertilisers leaves a buffer (no fertiliser) zone between the crop and sensitive areas such as watercourses and native vegetation.
- Ensuring workers are trained in practices that minimise the risk of environmental contamination from fertilisers and soil additives.

NOTE: Queensland Reef protection - Ground-based broadcast application of fertiliser containing nitrogen must **not** occur on the agricultural property.

Factsheet – E5 Nutrient management (Banana cultivation)

Freshcare Environmental Standard requires that a Nutrient Management Program (NMP) is documented in consideration of:

- The crop nutrient requirements.
- Fertilisers and soil additive budget.
- Application including justification and schedule.

The following sections provide further information on the areas that need to be considered when developing the Nutrient Management Program for your business.

Selecting nutrient types and amounts

The banana industry has greatly reduced the average annual application of nitrogen over the last 10 years, with nearly 80% of growers using 350 kg or less of nitrogen per hectare per year. This is applied in small amounts and frequently (e.g. fortnightly), greatly reducing the potential for loss.

In Reef catchments, all growers are required to develop a written Nutrient Management Plan (NMP) under the Queensland Reef protection regulations which should be based on:

- Crop requirement targets.
- Soil and leaf tissue test results.
- Soil type.
- Crop yield.
- Planting density.
- Application method.
- Risk of environmental impacts.

Each farm has slightly different target rates based on a combination of these factors. It is recommended professional advice is sought to develop a nutrient management plan.

Other important considerations for a Nutrient Management Plan include:

- It should include a standard ongoing fertiliser program and nutrient corrections identified by soil and leaf tissue tests.
- It should include the type of product to be applied, the application date and rate.
- It should be tailored to suit the growing conditions. For example, when the plant is not growing as actively over winter, the fertiliser intervals can be increased by a week or two, compared with the summer applications.
- If the crop is uniform, the program can be altered to suit the developmental stage. For example, potassium applications can be increased before bunch development in plant and nurse-suckered blocks.
- Consider a custom blend instead of a generic blend. This will avoid over-applying one element in order to apply enough of another. Generally, a minimum product order of four tonnes is required.
- Calculate the total nutrient applications using the analysis of all the fertilisers applied. This includes organic, inorganic and foliar and trace elements applied in weed sprays.
- Know your soil type and manage nutrient inputs to suit your soil. Lighter soils would benefit from smaller, more frequent applications.

Considerations for selecting fertilisers:

- Some forms of fertiliser can reduce the soil pH while others can increase the pH.
- The banana plant absorbs nitrogen in the form of ammonium and nitrate, but prefers the latter.
- Gaseous loss of nitrogen occurs in volatilisation and denitrification, which reduces the amount of applied nitrogen that the plant can use.
- Volatilisation can be avoided by irrigating ammonium-based products, such as urea and diammonium phosphate DAP, into the soil or by using nitrate-based products.

- Denitrification can be minimised by not applying nitrogen fertilisers during water-logged conditions.
- Consider whether the alternative of using slow release forms of nitrogen are more effective and economic for your requirements.
- Raw forms of animal manure can have high levels of nitrogen and phosphorus. Test the products and apply them at acceptable rates.
- Choose fertilisers that will not contaminate the soil with heavy metals (e.g. lead, mercury and cadmium). This is primarily relevant for poor quality fertilisers.

Soil and leaf testing

Soil and leaf tissue tests are the most reliable way to monitor the effectiveness of your nutrient management program when used in conjunction with each other.

Sap tests are not recommended as these results do not consistently relate to plant nutrient status in bananas.

Soil and leaf tissue tests should be taken at least annually, and from more than one site on the farm. A single test for the whole farm will not account for the variation across soils and blocks. Only combine blocks for sampling if they have same soil types, crop ages and ongoing fertiliser programs. Otherwise test blocks individually. Many growers in the North Queensland industry test each block twice a year in order to maintain high productivity while optimising total fertiliser inputs.

Suggestions for soil and leaf tissue tests:

- Use a competent, certified laboratory, that is part of the Australasian Soil and Plant Analysis Council (ASPAC) proficiency program (http://www.aspac-australasia.com/), or NATA accredited. This will ensure the tests are suited to Australian conditions and use consistent measurements.
- Seek professional advice for correct sampling procedures and interpretation.
- Soil tests are useful for understanding both nutrient levels and soil characteristics.
- Aim to take paired soil and leaf tissue tests annually.
- Paired soil and leaf tissue tests help determine how effective the fertiliser program is, and to identify any potential uptake problems. Sometimes an element may be at optimum levels in the soil and below optimum in the tissue. In this situation, adding more fertiliser will not necessarily address the limiting factor as there may be problems with nutrient uptake in the plant.
- Regular tests allow you to review the effectiveness of the fertiliser program and, combined with the corresponding yield data, they help identify where adjustments are required.
- As a minimum, tests should be carried out at least once a year, and the results of leaf tests for nitrogen and phosphorus should be kept as minimum standards records for your Freshcare Environmental audit (as well as the Queensland Reef protection regulations).
- Keep all test results and yield data on record and monitor trends. This will demonstrate how effective the fertiliser program is.
- Nitrogen cycles readily in the soil, so soil tests rarely show nitrogen at adequate levels, especially nitrate-nitrogen. Nitrogen is best monitored in the leaf rather than the soil. The exception is at planting where recent cultivation prior to planting causes nitrogen mineralisation, which may result in high nitrogen levels. In some cases these may be sufficient to meet the crop's needs.
- A soil test should be taken before planting to allow:
  - pH amending products to be applied and incorporated into the soil before planting
  - Elements such as calcium, magnesium, potassium and phosphorus to be applied (as determined with a soil test) and incorporated before planting
  - Leaf tissue tests should be conducted on the third fully unfurled leaf of an unbunched plant, to maintain sampling consistency.

Factsheet – E5 Nutrient management (Banana cultivation)

Under the Queensland Reef protection regulations leaf samples are only required for determination of nitrogen and/or phosphorus when application rates **exceed**, or are **expected to exceed**, the **threshold annual rates.**

i.e. you can sample for nitrogen alone and maintain phosphorus rates under or equal to the threshold annual rate, or vice versa.

Guidance on the requirements for leaf sample collections, to determine the amount of nitrogen and phosphorus that can be applied, is provided on page 10 of the ERA for banana cultivation.

Refer: www.qld.gov.au/__data/assets/pdf_file/0015/113145/prescribed-banana-methodology.pdf

The prescribed method outlines the following steps:

1. You must take leaf samples and use the results of leaf testing if you will be using fertiliser above the threshold annual rates. The leaf test results will allow you to monitor the effectiveness of nitrogen and phosphorus application.
2. Collect the sample from the third fully expanded leaf, from **at least 10** plants in the representative area (Figure 2 following). Samples should be obtained from plants with a similar age, and at a similar time of year to allow year-to-year comparisons to be made.
3. Place the leaf samples into a clean unused paper bag and label using a permanent ink marker with the: date; block or area sampled; and farm name.
4. Make a record of the leaf sampling locations. For example, this could be using GPS locations, or a record made of the block where sampling occurred. Keep a copy of your records.
5. Submit the leaf sample to a certified laboratory for testing.
    - the Australasian Soil and Plant Analysis Council (ASPAC): (http://www.aspac-australasia.com/)
    - the National Association of Testing Agencies (NATA). https://www.nata.com.au/accredited-facility

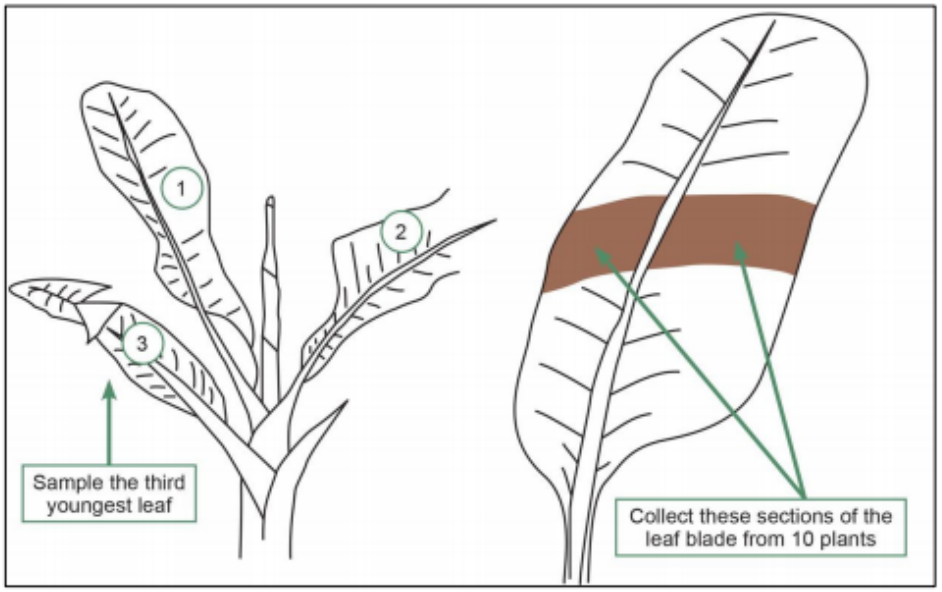


Figure 2: *How to collect a leaf sample* (Source: Armour 2018; NSW DPI 2016).

Nutrient budgeting and planning

All growers should calculate the amount of nitrogen, potassium and phosphorus that they will apply per hectare, per year.

This should be done in consultation with a qualified person and kept as a record in the Nutrient Management Plan. A **Nutrient Management Plan** (NMP)should include the following as a minimum:

- Farm map/s showing block boundaries, block identifiers, block area (ha), and leaf sampling locations.
- The results of leaf testing for nitrogen and phosphorus.
- Nitrogen and phosphorus recommendations by an appropriate person including recommended application rates and frequency of application.

- Annual nitrogen and phosphorus application rates applied.
- Once established, the Nutrient Management Plan must record the annual yields achieved (for example as the total number of cartons per year per farm, the amount of bananas produced per year per farm, or the amount of bananas sent to market per year per farm).
- Names, date and contact details of the appropriate person(s).

In Queensland Reef protection regulations, if the rates of nitrogen and/or phosphorus application are higher than the thresholds (outlined in the table below) the NMP must be updatd and maintained kept in accordance with **Record keeping – Queensland Reef protection below.**

Crop stage	Nitrogen kg/ha/year	Phosphorus kg/ha/year
Plant	280	60
Ratoon	400	60

The farms nutrient budget needs to take into account what is required to grow a commercial crop of bananas.

Over-application of fertiliser can impact on the environment through leaching and runoff.

Under-application is also an environmental concern, as continual cropping will mine the soil of nutrients, gradually reducing soil fertility.

- Older plant blocks and ratoons in the tropics generally require about 20-30 kg of nitrogen, 60-70 kg of potassium, 4-7 kg of phosphorus per hectare per month. This is a guide only, and soil and leaf tissue tests should be used as a guide for exact application rates.
- Consider whether additional nutrients have been applied in irrigation water (not fertigation) and organic amendments. These should be factored into the fertiliser program to determine the total application amount.
- Fertiliser applications should be matched to crop stage in plant blocks. Young plant crops do not require as much fertiliser because they are smaller, so where possible, target the fertiliser application to suit the smaller root system.

Application of fertilisers and soil additives

When applying fertilisers and soil additives, some general rules should be followed:

- Incorporate pre-plant pH amending products, calcium, magnesium, potassium and phosphorus into the soil, rather than applying them to the soil surface.
- Organic matter and ground cover will slow the speed of water passing over the soil surface, allowing increased infiltration and reducing nutrient loss in surface runoff.
- Maintain a healthy plant and root system.
- Avoid applying fertiliser immediately before intense rain or to water logged soils.

If behind in the fertiliser program, make the applications more frequently and avoid the temptation to simply make up the difference in a single application, which would make leaching and surface runoff more likely to occur.

Fertiliser applications can be applied either through fertigation, foliar or broadcast applications (exception below).

Additional requirements for banana producers in Reef catchments

- Ground-based broadcast application of fertiliser containing nitrogen must **not** occur on the agricultural property.
- Ground-based broadcast application of fertiliser containing phosphorus (and not nitrogen) must **not** occur on the agricultural property unless:

a) in preparation for the impending establishment of a plant crop; and

b) the fertiliser is incorporated into the soil within three (3) days of application.

All application methods have their place in a fertiliser program so choose the system that best suits your needs.

- **Fertigation** provides an efficient application method as it provides the fertiliser in a readily available form, directly to the plant's roots. However, a poorly designed irrigation system with uneven distribution throughout the block is not a suitable application method.
- When **broadcasting**, it is preferable to apply fertilisers to the banana root zone. In a row configuration, avoid broadcast fertiliser spreaders that apply fertiliser to the whole area, including the inter-row space.
  - Calibrate your fertiliser spreader regularly.
  - If broadcasting by hand it is important to use an application technique that accurately measures the amount of fertiliser you apply e.g. a small cup or container.
  - If fertilising every fortnight seems too time consuming, aim for every other row, every alternative application (every 2nd row, every 2nd week).
- **Foliar** applications are effective for applying trace elements and help to correct some short term deficiencies when there are uptake problems.
- Important factors to consider when **fertigating** are:
  - Use soil moisture monitoring devices to prevent over-watering, which results in leaching past the root zone.
  - Monitor your irrigation system performance to ensure an even distribution of nutrients.
  - Use the correct injection duration – the minimum injection duration is the time it takes fertiliser to move from the first emitter in the block to the last.
  - Use the correct flush time – the minimum flush time is the time taken for fertiliser to travel from the fertigation tank to the furthest emitter. Growers consulted on this topic measured the time taken for fertiliser to move through the fertigation system with the aid of nitrogen test strips and marker dyes. Some growers used sheets of paper on the ground with the marker dyes.
- Use the correct fertiliser concentration – concentrations vary during fertigation, depending on how the fertigation tank and injection is managed.
  - DO dissolve the fertiliser and allow it to run out without topping up the water level in the tank to maintain the same concentration
  - DO understand the capacity of your tank and only apply as much fertiliser as the tank can dissolve
  - DO inject the fertiliser for at least the minimum injection time, longer if possible
- Seek professional advice on system design and performance for both new and existing systems.
- As a minimum, fertiliser should be applied every four weeks and preferably more regularly. In the east coast subtropics, it is common to apply fertiliser four times a year. Increasing the frequency may be difficult due to the manual nature of application, however the more frequent the application the better for plant utilisation and less risk of surface erosion.
- For optimum nitrogen uptake in the tropics, application intervals should not exceed three weeks. Research in bananas in far north Queensland using nitram (ammonium nitrate) with isotope N15 (nitrogen tracer) found most nitrogen was absorbed in the first three weeks following application. Without a further application after three weeks, nitrogen levels decreased in plant tissue. This trial also found some nitrogen was present in the plant three days after ammonium nitrate was applied.
- Research demonstrated that when using broadcast urea, up to 30% of the nitrogen can be lost through volatilisation. This means urea may no longer be the cheapest form of fertiliser. To prevent volatilisation, apply sufficient irrigation after applying ammonia based fertiliser, such as urea, to dissolve and wash it into the soil or use coated products.
- **Maximising crop uptake** – The banana plant will only take up as much nutrient as the root system allows. Water logging, compaction or pests such

as nematodes will affect the plant's ability to access nutrients, so applying more fertiliser will not necessarily help the plant to take up more nutrients.

- Nitrogen applications are not only about the overall annual targets, but also consider the amount applied in a single application. Smaller, frequent applications are critical in climates with high rainfall.
- The availability of phosphorus to plants is reduced in some soils due to chemical bonding with aluminium, iron and calcium. When developing a nutrient program, it is vital the soil tests also measure the Phosphorus Buffering Index (PBI). The PBI is a measure of the ability of a soil to adsorb phosphorus, making it less available to the plant. Paired leaf tissue and soil tests are especially useful on high PBI soils because the leaf tissue test will indicate if there is an uptake problem.
- Adequate soil moisture is important because roots access nutrients from the soil solution. If the soil is too dry, nutrients present in the soil will be difficult for the plant to access.

Storage of fertilisers and soil additives

All fertilisers including animal manures should be stored in such a way that prevents nutrients leaching into surface watercourses and groundwater. Inorganic fertilisers should be stored in a covered area away from watercourses. Manure heaps should also be covered to reduce leaching through rain.

Inorganic fertiliser storage areas should be:

- Protected from direct sunlight and rain.
- Well ventilated with fresh air to keep fertilisers dry.
- Designed to minimise the chance of pest infestation, mould growth and damage.
- Designed to confine any spillage and allow easy clean up.

Store fertiliser in a way that lowers the risk of seepage into groundwater. With the exception of fertilisers applied with agricultural chemicals, fertilisers should be stored separately from agricultural chemicals.

All liquid fertiliser storage should be bunded to eliminate the chance of run-off into watercourses. In the absence of any national or state legislation, the bund should be 125% of the largest container, plus 25% of total volume stored.

In addition to regulations regarding storage of dangerous goods, there are regulations in place regarding "security sensitive" ammonium nitrate (SSAN) that cover how these products are supplied, handled and stored. Advice from the appropriate local authority should be sought.

Bulk animal manure and compost storage areas should be:

- located away from watercourses and flood-prone areas,
- bunded to prevent surface water running through the piles and to contain leachate surface flow,
- on an impervious base to prevent leachates entering ground water,
- covered where possible.

A current Safety Data Sheet (SDS) (or ingredient specification) should be kept for fertilisers stored on the property. These should be located near to where the fertiliser is stored and easily accessible. SDS's can be obtained from the supplier of the fertiliser or sourced online.

Record keeping

An accurate record of all fertiliser and soil additive applications should be maintained, including foliar application and fertigation. This applies both to organic (e.g. sheep, cattle, chicken manure) and inorganic fertilisers (e.g. superphosphate). Fertiliser application records are essential for nutrient budgeting, and a requirement of the Freshcare Environmental Code of Practice.

Freshcare Form - E5 (modified) Fertilisers and soil additives application record - bananas can be used to capture this data.

Factsheet – E5 Nutrient management (Banana cultivation)

Whilst growers can choose to record information using paper-based methods, electronic versions are generally more suited to this type of application and can be as simple as a Microsoft Excel spreadsheet or software/apps tailored to your business.

Records should also be kept for servicing and calibrating fertiliser equipment and machinery.

Growers are given free access to the **BetterBunch** App, developed by ABGC, to support this record keeping: records.bmp.abgc.org.au

Record keeping – Queensland Reef protection regulations

In reef catchments, records must include below supported by primary documents such as: leaf test reports, fertiliser contractor print-outs, fertiliser invoices etc. as proof of the **records for six (6) years.**

Crop stage	Nitrogen kg/ha/year	Phosphorus kg/ha/year
Plant	280	60
Ratoon	400	60

For growers using <u>less</u> than the threshold rates of nitrogen and phosphorus application (in table above) the following records must be maintained:

1. Amounts of nitrogen and phosphorus (kg/ha) calculated for each block using the Prescribed methodology for banana cultivation available at www.qld.gov.au/ReefRegulations
2. Method of fertiliser application.

For grower using <u>higher</u> than the threshold rates of nitrogen and phosphorus application (in table above) a Nutrient Management Plan (NMP) must be kept and include the following:

1. Farm map(s) showing block boundaries, block identifiers, block area (ha), and leaf sampling locations.
2. The results of leaf testing for nitrogen.
3. The results of leaf testing for phosphorus.
4. Annual nitrogen and phosphorus application rates applied (kg/ha/yr).
5. Annual yields achieved (for example, the total number of cartons per year per farm).
6. Nitrogen and phosphorus recommendations from appropriate person(s), including:
    a. recommended application rates
    b. appropriate frequency of application.
7. Names, date and contact details of the appropriate person(s) who have developed and verified the nutrient management plan for the agricultural property.
8. The NMP must be reviewed and updated at least annually.
9. Review and update must include
    a. a recalculation of the annual N and P amounts based on latest leaf test results (as per prescribed methodology)
    b. an update to the farm map; and
    c. any other changes that may affect the amount of fertiliser calculated (as per prescribed methodology).

The NMP then must be reviewed, updated and verified by an appropriate person(s) every 5 years.

Refer to the Freshcare Form – E5 Nutrient Management Plan- Bananas if a Nutrient Management Plan template is required.

If you would like assistance in completing a Nutrient Management Plan, contact Amelia Foster, ABGC - BMP Coordinator E: amelia@abgc.org.au.