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**
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- **Record keeping**
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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 Government reef regulations and the Freshcare Environmental – 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

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.

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The regulated minimum practice agricultural standards (Queensland) have been adopted to deliver significant water quality benefits for 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.

The Standard requires that a Nutrient Management Program is documented in consideration of:

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

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

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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.

All growers are required to develop a written Nutrient Management Plan 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.

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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 similar 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 laboratory, preferably one that is part of the Australasian Soil and Plant Analysis Council (ASPAC) proficiency program (http://www.aspac-australasia.com/). 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 Queensland Government Reef Protection Regulations as well as for your Freshcare Environmental audit.
- 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.

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 I can be applied, is provided on page 10 of the ERA for banana cultivation visit 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.

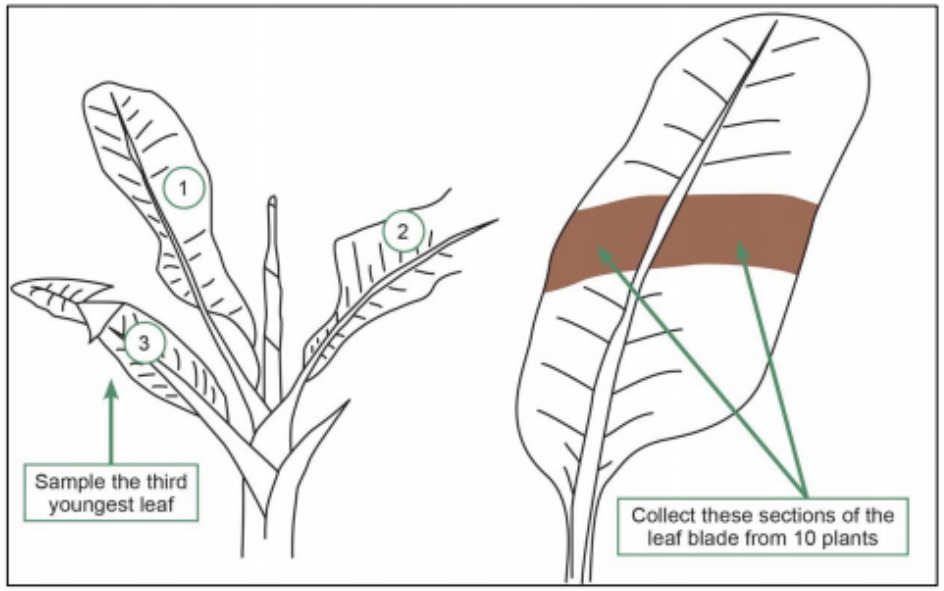

Figure 2: *How to collect a leaf sample* (Source: Armour 2018; NSW DPI 2016).

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 competent laboratory for testing.

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.

For banana cultivation in reef catchments, growers must take into consideration the requirements in the minimum practice standards as outlined in the *Environmental Protection Act 1994 - Reef Protection Regulations* for Queensland Banana producers.

If the rates of nitrogen and/or phosphorus application are higher than the thresholds (outlined in the table below) the nutrient plan must utilise the results of leaf testing.

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

A **Nutrient Management Plan** 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).

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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.

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 annual targets, but also 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.

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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.

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 – Reef catchments

For banana producers in reef catchments, minimum standard records must specifically include the following with supporting primary documents including, leaf test reports, fertiliser contractor print-outs, fertiliser invoices etc. as proof of the records.

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 must be documented and include the following:

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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 an appropriate person, 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.

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