The method for calculating the amount of nitrogen (N) and phosphorus (P) to be applied to banana properties regulated under the *Environmental Protection Act 1994*

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Introduction

Who is this document for?

If you grow bananas commercially in any part of the Great Barrier Reef catchment, this method must be used to calculate fertiliser application rates to comply with the Reef protection regulations for nutrient application. You can check if your property is in the Great Barrier Reef catchment by using this tool [INSERT LINK TO TOOL]. The additional explanatory information in this method is intended for use by growers, and others involved in suppling nutrient recommendations on agricultural properties.

Using the correct rate of fertiliser plays a critical role in reducing fertiliser losses in run-off, to the air or through the soil profile. Applying fertiliser according to the crops needs minimises the chance of losses off-farm; can result in more efficient uptake of fertiliser by the plant; and increase farm profitability and productivity.

The calculated amount relates to the kilograms of nitrogen and phosphorus to be applied per hectare (kg/ha), per year. The amount per year is defined from the first application of fertiliser after the crop is established and this date is maintained as the crop is ratooned. For ratoon crops where the planting date is unknown, this period is defined from the first application in a calendar year. This method refers to a fertiliser rate and the 'kg' refers to the actual amount of nitrogen or phosphorus (i.e. the nutrient content) in the fertiliser product, not the product application rate. The nutrient content of the fertiliser product can be found on the label or from the supplier for a custom blend. The nutrient amounts in this guide focus on nitrogen (N) and phosphorus (P), the two nutrients of environmental importance because of the risk they pose to water quality in Great Barrier Reef coastal and marine ecosystems.

Purpose of this document

To describe the method for calculating the amount of nitrogen (N) and phosphorus (P) to apply to banana agricultural properties in accordance with the Banana Cultivation Standard 1 under the *Environmental Protection Act 1994* by:

- outlining the methods for calculating fertiliser rates on banana growing properties.
- outlining requirements for leaf testing, which is required when using a Nutrient Management Plan to calculate fertiliser rates.
- providing information on where to find help and further information.

What do I need to do?

When working out your crops nutrient requirements on a block basis or management zone there are two options available for you to determine the amount of fertiliser containing nitrogen and/or phosphorus to apply to your crop.

Option 1 – Apply nitrogen and/or phosphorus rates lower than, or equal to the threshold rates for either plant or ratoon crops. These rates are shown in Figure 1 and Table 1 below.

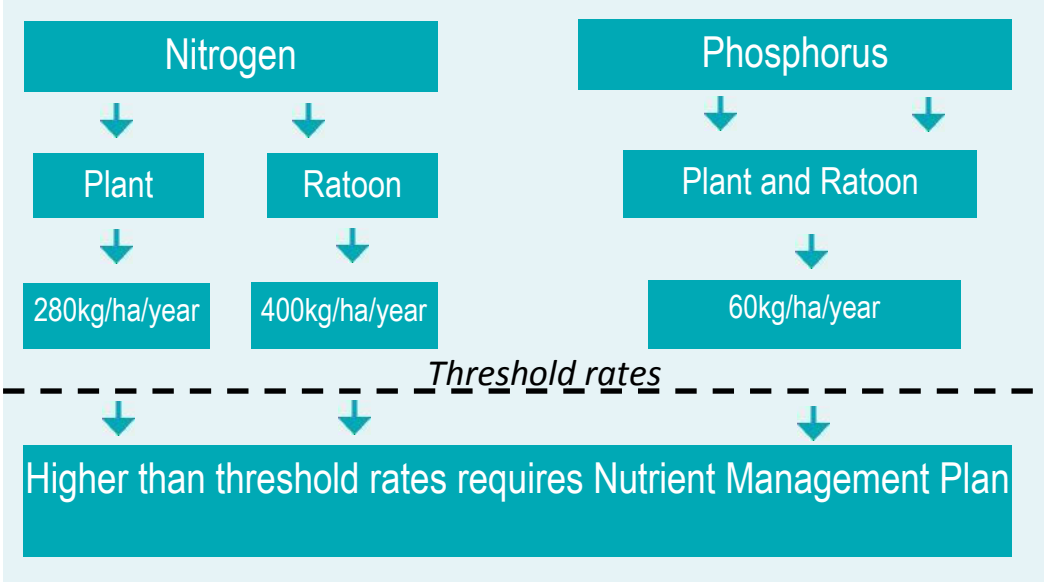

Figure 1: Nitrogen and Phosphorus threshold rates and when a Nutrient Management Plan is required.

Option 2 – Develop a Nutrient Management Plan using the results of leaf testing (see leaf sample collection on page 7 for more information) to adjust rates of nitrogen and/or phosphorus according to the plants needs and apply fertiliser accordingly. Whichever option you choose, you must not apply more than the application rate calculated by either method. You can find more detail on how to follow each method in the following sections.

Option 1. I am not going to go higher than the threshold annual rates

If you decide to use nitrogen and/or phosphorus application rates that will not go higher than the rates outlined in Table 1 you are required to make a record of the rates of nitrogen and phosphorus applied, a farm map showing block boundaries, the block/s where nitrogen and phosphorus is being applied and a description of the method of application used.

Table 1: Threshold annual rates of nitrogen and phosphorus

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

Option 2 developing a nutrient management plan

A Nutrient Management Plan must be developed and implemented for a banana agricultural property or a Single Integrated Operation when the annual nitrogen and/or phosphorus application rates that will be higher than the threshold rates in Table 1 will be applied. A Nutrient Management Plan must have the following elements:

- farm map/s showing block boundaries and a unique identifier (e.g. a block number)
- block area
- management zones (if leaf samples are representative for a number of similar blocks or fertigation infrastructure supplies a number of similar blocks)
- nitrogen and phosphorus application rate recommendations from an Appropriate person including appropriate frequency of application

- leaf analyses reports for specific blocks and application rates where above the threshold amounts of nitrogen and/or phosphorus will be applied
- records of nitrogen and phosphorus application
- once established, the Nutrient Management Plan must record yields achieved - total number of cartons/year/farm (i.e. 13kg, 15kg or other)

A Single Integrated Operation is the area where:

(a) the activity is carried out under the day-to-day management of a single responsible individual, for example, a site or operations manager; and

(b) the activity is operationally interrelated; and

(c) the activity is, or will be, carried out at 1 or more places; and

(d) places where the activities are carried out are separated by distances short enough to make feasible the integrated day-to-day management of the activities; and

(e) the activity is carried out within the same basin

Your Nutrient Management Plan must use the results gained through leaf testing to justify the need to apply nitrogen and phosphorus rates above the threshold limits. Ongoing research on banana farms in the Wet Tropics may inform future amendments to these thresholds or fine-tuning the testing procedures required to work out the best application rates to use.

For increasing the application rate of nitrogen above the threshold amount, a Nutrient Management Plan must include the use of leaf testing results to guide application rates, using a starting nitrogen application rate of up to 280 kg N/ha/year for Plant Crops, and 400 kg N/ha/year for Ratoon Crops, then adjusting nitrogen rates depending on the concentration of nitrogen gained through leaf testing.

For increasing application rate of phosphorus above the threshold amount, a Nutrient Management Plan must include the use of leaf testing results to guide application rates, using a starting phosphorus application rate of up to 60 kg P/ha/year for Plant Crops or Ratoon Crops, then adjusting phosphorus rates depending on the concentration of nitrogen gained through leaf testing.

There are a number of stages associated with developing your Nutrient Management Plan. More details are provided in the following sections.

Farm map	
Develop a farm map clearly showing block boundaries, area of each block (ha) and soil types	
Leaf testing	
Leaf sample collection	
Leaf analysis in the laboratory	
Laboratory selection	

Send samples for analysis	
Record keeping	
Interpretation of results	
Use leaf test results to determine nitrogen rates for plant crops	
Use leaf test results to determine nitrogen rates for ratoon crops	
Use leaf test results to determine phosphorus rates for plant and ratoon crops	

Development of a farm map

Farm map

Your Nutrient Management Plan must include a farm map for your property that includes as a minimum:

- Block boundaries
- Block area (ha)
- Management Zones

Your Nutrient Management Plan must also record the following information and your farm map may also include:

- Leaf sampling locations
- Fertiliser recommendations
  - % N
  - % P
  - Product application rate (kg/ha)
- Records of nitrogen and phosphorus applications
- Yield i.e. total number of cartons/year/farm

How do I collect a leaf sample to determine the amount of nitrogen and phosphorus that I can apply?

Leaf sample collection

- The development of your Nutrient Management Plan, including leaf sampling, must be undertaken before applying fertiliser above the threshold rates in order to monitor the effectiveness of nitrogen and phosphorus application and validate higher rates of nitrogen and phosphorus.
- Collect the sample from the third fully expanded leaf, from at least 10 plants in the representative area (Figure 2). Samples should be obtained from plants with a similar age at a similar time of year to allow year-to-year comparisons to be made.
- 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.

Submit the leaf sample to a certified laboratory for testing (see laboratory selection on page 8 below).

- Make a record of the plants that the leaf samples have been taken from. For example, this could be using GPS locations or written on a farm map.

Attachment 1 provides a form suitable for recording information about the block or sampled areas and submitting with the leaf sample to the testing laboratory. Keep a copy of this form for your records.

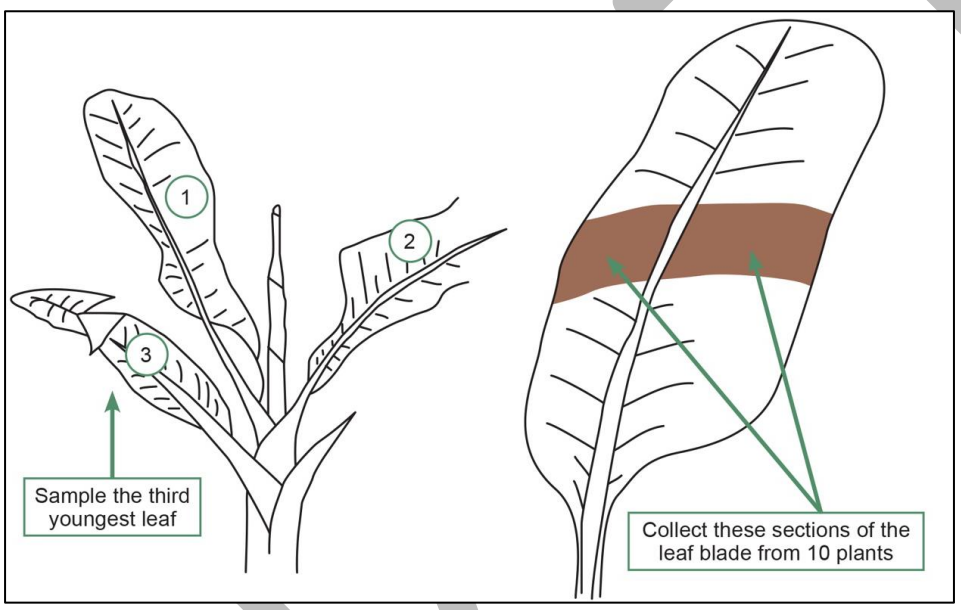

Figure 2: How to collect a leaf sample (Source**:** Armour 2018; NSW DPI 2016).

Leaf analysis in the laboratory

Laboratory selection

Your Nutrient Management Plan will need to have leaf sampling results included if nitrogen and/or phosphorus application rates are recommended to be higher than the threshold rates. Leaf samples will only be required for nitrogen and/or phosphorous that your plant requires, that will be higher than the threshold rates, i.e. you can sample for nitrogen alone and maintain phosphorus rates under or equal to threshold rates.

Your leaf samples must be sent to a suitable laboratory. A suitable laboratory is one that:

- is certified by the Australasian Soil and Plant Analysis Council (ASPAC). This ensures that the tests comply with Australian standards and that the results are applicable to Australian conditions. Laboratories may also be certified by the National Association of Testing Agencies (NATA).

Send samples for analysis

Send your samples to your chosen laboratory for nutrient analysis. If you are using a professional fertiliser industry advisor to make recommendations on how much nutrient to apply, ensure they produce recommendations consistent with the method outlined in this document.

A professional advisor is an individual who meets the following national competency standards:

i) AHCWRK301A – Collect samples for a rural production and horticulture monitoring program (this supercedes RTE3504B)
ii) AHCPCM402A – Develop a soil health and plant nutrition program (this supercedes RTF4004A)
iii) AHCPCM505A – Conduct environment and food safety risk assessment of plant nutrition and soil fertility programs (this supercedes RTE5527A)

Fertcare Accredited Advisors meet these standards.

Note: Other tests, such as soil tests, to determine soil pH or available potassium, calcium and magnesium are encouraged for assessing the overall fertility status of the soil and to develop a balanced nutritional program for the crop. You may also wish to soil test for available phosphorus (Colwell P (extractable phosphorus)) and nitrogen when planting your crop to help guide fertiliser recommendations. However, soil tests are not a requirement of the Nutrient Management Plan at this time.

Record keeping

It is important that you keep a record of activities relating to fertiliser application on your banana growing property. The following records must be kept for at least six years:

- the location of plant(s) from which leaf samples have been taken for testing
- the name of the person conducting the test and their relevant experience or qualification
- leaf testing results as a report from the suitable laboratory or accredited advisor
- Records of nitrogen and phosphorus applications
- Yield i.e. total number of cartons/year/farm
- Fertiliser recommendations
    - % N
    - % P
- Product application rate (kg/ha)
- invoices from the purchase of fertiliser.

How do I calculate fertiliser application rates (N and P) using the results of leaf tests for both plant and ratoon crops?

Interpretation of results

The following sections show you how to calculate nitrogen and phosphorus application rates based on leaf sampling results. You can find contact details of organisations to help you determine fertiliser rates in the Contacts section at the end of this document.

Figure 3 outlines the process to determine the application rate of nitrogen fertiliser to apply to banana crops and ratoon crops when using a Nutrient Management Plan. Figure 4 outlines the process to determine the application rate of phosphorous fertiliser to apply.

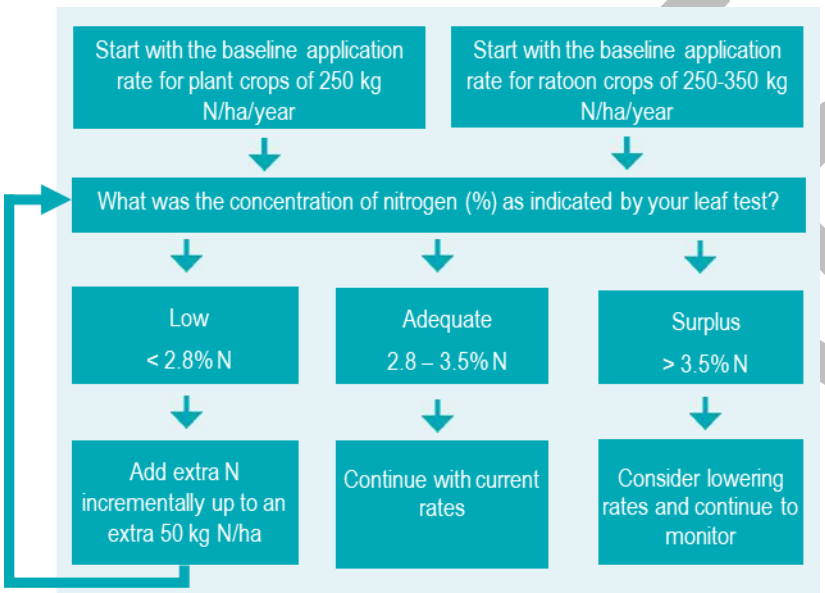

Figure 3: The process for determining the application rate of nitrogen on banana crops and ratoon crops.

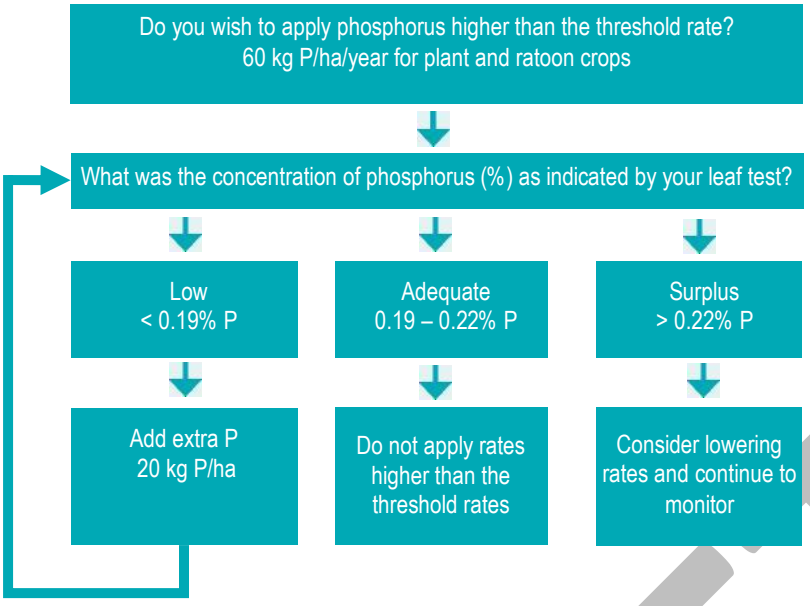

Figure 4: The process for determining the application rate of phosphorus on banana blocks.

Stage 1: How do I determine the application rate of nitrogen fertiliser to apply to plant crops?

Step 1.1: Leaf testing is only required where higher than the threshold rate of 280 kg N/ha is to be applied.

Step 1.2: This rate can then be modified by using the nitrogen concentration determined from leaf testing. Take a leaf sample half-way through the crops growth period, and send it to a laboratory to be tested for nitrogen concentration (see leaf sample collection on page 7 for more information).

Step 1.3: Once you have your leaf test results, use Table 2 to determine if the plant crops' nitrogen concentration is low, adequate or surplus.

Table 2: Concentration of nitrogen in leaf tests (Armour 2018).

Element	Low	Adequate	Surplus
% of Nitrogen	< 2.8	2.8 – 3.5	> 3.5

Step 1.4: If the results show that nitrogen concentration is **adequate** or **surplus**, you must not adjust nitrogen application rates above the threshold amount (see Figure 3). However, you may choose to reduce nitrogen application rates, particularly if there is a surplus concentration, and continue to monitor nitrogen levels.

Step 1.5: If the results show that nitrogen concentration is **low**, you can add extra nitrogen in increments of 50 kg N/ha, you will need to conduct further leaf testing to add extra increments of 50 kg N/ha.

Stage 2: How do I determine the application rate of nitrogen fertiliser to apply to ratoon crops?

Step 2.1: Leaf testing is only required where higher than the threshold rate of 400 kg N/ha is to be applied.

Step 2.2: This rate can then be modified using the nitrogen concentration determined from leaf testing. Take a leaf sample half-way through the crops growth period, and send it to a laboratory to be tested for nitrogen concentration (see leaf sample collection on page 7 for more information).

Step 2.3: Once you have your leaf test results, use Table 2 to determine if the ratoon crops nitrogen concentration is low, adequate or surplus.

Step 2.4: If the results show that nitrogen concentration is adequate or surplus, you must not adjust nitrogen application rates above the threshold amount (see Figure 3). However, you may choose to reduce nitrogen application rates, particularly if there is a surplus concentration, and continue to monitor nitrogen levels.

Step 2.5: If the results show that nitrogen concentration is low, you can add extra nitrogen in increments of 50 kg N/ha, you will need to conduct further leaf testing to add extra increments of 50 kg N/ha.

Stage 3: How do I determine the application rate of phosphorus fertiliser to apply to plant and ratoon crops?

Step 3.1: Leaf testing as part of your Nutrient Management Plan is only required where higher than the threshold rate of 60 kg P/ha is to be applied.

Step 3.2: This amount can then be modified using the phosphorus concentration determined from leaf testing. Take a leaf sample half-way through the crops growth period, and send it to a laboratory to be tested for phosphorus concentration (see leaf sample collection on page 7 for more information).

Step 3.3: Once you have your leaf test results, use Table 4 to determine if the crops' phosphorus concentration is low, adequate or surplus.

Table 4: Concentrations of phosphorus in leaf tests (Armour 2018).

Element	Low	Adequate	Surplus
% of Phosphorus	< 0.19	0.19 – 0.22	> 0.22

Step 3.4: If the leaf test results show that phosphorus concentration is adequate or surplus, you must not adjust phosphorus application rates from the amount shown in Table 1. However, you may choose to reduce phosphorus rates and continue to monitor phosphorus levels.

Step 3.5: If the leaf test results show that phosphorus levels are low, you can add extra phosphorus in increments of 20 kg P/ha, you will need to conduct further leaf testing to add extra increments of 20 kg P/ha.

Contacts

For further information on soil and leaf testing and determining nutrient rates, you can contact the following organisations:

Department of Agriculture and Fisheries (DAF) extension officers can be contacted on:
13 25 23 (cost of a local call within Queensland), or 07 3403 6999
callweb@daf.qld.gov.au
WWW https://www.daf.qld.gov.au/about-us/contact-us
Regional offices are located in Cairns, Mareeba and South Johnstone.

Australian Banana Growers Council extension officers can be contacted via:
07 3278 4786
info@abgc.org.au

Local agronomy providers

You can find your local Natural Resource Management group at:
WWW www.nrmrq.org.au/find-your-regional-group/

References

Armour 2018. *Nutrient Management Plan for the Banana Industry (of north Queensland)*, prepared for the Australian Banana Growers' Council. Viewed 18 February 2018, <https://abgc.org.au/wp-content/themes/abgc/assets/lib/magazine/magazine.html?file=https://abgc.org.au/wp-content/uploads/2018/04/Ban-NMP_submit-R1.pdf#magazineMode=true>.

Incitec Pivot, 2016. *Agronomic insight: Stay on track with petiole and leaf tests*, viewed 18 February 2019, <https://www.incitecpivotfertilisers.com.au/news-and-insights/agronomic-insights/testing/stay-on-track-with-petiole-and-leaf-tests>.

NSW DPI 2016. *Sub-tropical banana nutrition – matching nutrition requirements to growth demands*, Department of Primary Industries, NSW Government.

Attachment 1. Record keeping form for leaf samples

If your chosen laboratory doesn't provide form/s to record your leaf sampling details, complete this form for each representative set of leaf samples that you submit to the accredited laboratory for testing. Keep a copy for your records.

Grower name……

Property address ……

Farm name / ID number ……

Contact number ……

Block/Area sampled (provide details below) ……
Block/Area identifier …… ……
List the blocks (using their identifiers) that this leaf test represents …… …… …… ……
Date of leaf sampling ____/____/___
Leaf sample reference number