AFRICA soil health consortium

# Nutrient management

# Banana

**Residue management**
One of the major benefits of growing banana and coffee together is that the banana provides mulch and soil cover that benefits both crops.

In mature plantations, some of the nutrients taken up by plants are returned or recycled to the soil through leaf-fall and prunings of coffee and unwanted suckers, banana pseudostems felled at bunch harvest and corms from banana. In addition, there may be prunings from shade trees, banana peels from locally consumed bananas and plantains, and coffee husks and pulp from the coffee pulpery.

As well as providing mulch cover, retaining these plant materials in the plantation means that less external inputs, such as mineral fertilizers, are required to replace nutrients removed in harvested products (coffee berries, banana bunches) and to increase yields of coffee and bananas.

The amount of nutrients contained in suckers, pseudostems, trash and leaves of banana and leaves and husks of coffee in a plantation, even with a relatively low yield of 10 tonnes per hectare per year of fresh banana and 0.5 tonnes per hectare per year green beans of coffee, is equivalent to the nutrients supplied by 200 kg urea, 50 kg TSP and 370 kg potassium chloride (commonly referred to as muriate of potash or MOP) fertilizer.

If banana residues are removed from the farm and fed to livestock, animal manure collected from the livestock pens can be returned to the field.

Nutrients released by decomposition of soil organic matter or weathering from the soil mineral fraction is only a small part (less than 10%) of what is recycled every year with crop residues and is insufficient to meet the crops' requirements for good yields. For this reason, mineral fertilizers are required. Always keep in mind that:

- Removal of plant parts from the fields depletes the nutrient capital contained in the banana–coffee system.
- Returning crop residues to the system, or feeding such residues to livestock and then applying manure from these livestock to the

system, recycles but does not add nutrients to the system.
- Applying residues of crops/plants that have been grown elsewhere to the field/farm adds nutrients to the system.
- Grazing livestock in other fields (e.g. grazing lands on hillsides) and using manure from such livestock on the farm adds nutrients to the system.

Apart from supplying nutrients, applying crop residues to the soil also provides benefits including the following:
- Conservation of soil moisture.
- Mulch layer helps to reduce soil erosion on sloping land.
- Weed suppression and reduced requirement for weeding operations and therefore reduced soil disturbance and damage to banana and coffee feeder roots that lie close to the soil surface.
- Increased root development in the surface soil.
- Replenishment of soil organic matter.

**Organic inputs and mineral fertilizers**
All plants require an adequate supply of nutrients to grow and yield well and banana and coffee are no exception. For example, young plants require phosphorus for good root establishment and growth, and mature plants require potassium for effective flowering and fruit filling.

If the supply of nutrients is insufficient, production decreases and coffee may be affected by die back. Unlike legumes, which require phosphorus (P), and cereals, which require nitrogen (N) and phosphorus, both banana and coffee need large amounts of potassium (K) as well as phosphorus and nitrogen.

Deficiencies of the macronutrients nitrogen, phosphorus and potassium, and also sulphur, magnesium and calcium, and the micronutrients zinc, boron and iron lead to the appearance of leaf nutrient deficiency symptoms in banana and coffee that can be detected in the field.

Nutrient requirements can be supplied as organic inputs (i.e. crop residues or animal manure), mineral fertilizers or a combination of both.

Using organic inputs in combination with fertilizers may increase the efficiency of fertilizer use: when fertilizers are applied in the presence of organic residues, more of the nutrients contained in the fertilizer are taken up

by the crops.
Unlike fertilizer nutrients, which are readily available to plants, organic inputs need time to decompose and release nutrients and are therefore a 'slow release' source of nutrients to plants.

Legume crop residues decompose and release their nutrient content more rapidly than cereal straw.

The concentration of nutrients in organic resources is low and therefore much larger quantities of organic matter are required to supply a given quantity of nutrients by comparison with mineral fertilizers.

For example, fresh goat manure on average contains 7 kg P per tonne (equivalent to 16 kg per tonne $P_2O_5$[1]). By comparison, one tonne of triple superphosphate (TSP) fertilizer contains 200 kg P or 460 kg $P_2O_5$. If the goal is to apply 50 kg/ha $P_2O_5$, this could be delivered in about 3 tonnes of goat manure but just 109 kg TSP.

If the farmer does not have livestock and plans to buy animal manures it is worthwhile to compare the cost of nutrients in fertilizers and animal manures and then select the least costly source.

**Mineral fertilizer**
The four 'rights' help farmers get the most benefit from fertilizers:
- apply the right fertilizer
- at the right rate
- at the right time
- in the right place.

*Newly established banana-coffee systems*
During the first few years of a newly established banana-coffee system, fertilizers can be applied separately to each immature crop.
In mature banana–coffee intercrops, however, it is not really practicable to target fertilizers to one or other of the two crops; by the time the system has started to yield, root systems of both crops will have formed an overlapping, continuous web of roots.

1 Fertilizers are labelled to show the amount of N, P and K in them, for example 15-15-15. The first number shows the % of N in the fertilizer. The second number shows the % of P expressed as the equivalent amount of the salt $P_2O_5$ ($P_2O_5$ contains 43% P. The third number shows the % of K expressed as the equivalent amount of the salt $K_20$ ($K_20$ contains 83% K).

**The right fertilizer at the right rate**: Tables 3 provides suggested ranges of fertilizer suitable for applying to immature banana trees during the first 2 years and Table 4 does the same for immature coffee trees during the first 3 years.

All three fertilizers need to be applied: urea supplies N, TSP supplies P and MOP supplies K.

The lower end of the range is most suited to relatively fertile soils and the higher end for soils which are relatively low fertility; for example, if a farmer has a relatively fertile soil then 130 g urea and 45 g TSP and 335 g MOP would be suitable.

Farmers who have applied little or no mineral fertilizers and little or no organic matter to continually cropped plots during the past few years are likely to have low fertility soils. Other indications of soil fertility include yields achieved over the past few seasons – were these similar to the best neighbouring farmers or were they much lower? Stunted plants and abnormal colour leaves, combined with low yields also suggest nutrient deficiencies. If possible, it is a good idea for banana-coffee farmers to have a soil and leaf test done to determine the nutrient status of the soil.

**Table 3: Suggested fertilizer rates for immature banana in sub-Saharan Africa**

| Year | Urea | and TSP | and MOP |
|---|---|---|---|
| | g per tree | | |
| 1 | 130 - 150 | 45 - 65 | 335 - 435 |
| 2 | 150 - 200 | 90 - 175 | 420 - 500 |

## Table 4: Suggested fertilizer rates for immature coffee in sub-Saharan Africa

| Coffee type | Urea | and TSP | and MOP |
|---|---|---|---|
| | g per tree | | |
| Arabica year 1 | 45-65 | 10 - 20 | 35 - 50 |
| Arabica year 1 | 65-110 | 20 - 35 | 50 - 85 |
| Arabica year 1 | 110-200 | 35 - 55 | 85 - 150 |
| Robusta year 1 | 90-130 | 20 - 45 | 70 - 100 |
| Robusta year 1 | 130-220 | 45 - 65 | 100 - 170 |
| Robusta year 1 | 260-390 | 65 - 110 | 170 - 300 |

**Farmer friendly fertilizer measurements**

It is difficult for farmers to know what 45 g of urea or 10 g TSP fertilizer looks like and few will have access to weighing scales.

The solution to this problem is to identify a locally available container, such as discarded plastic water bottle. By cutting the neck off the water bottle, the resulting cylinder can be used as a handy scoop for measuring fertilizer.

Different fertilizers have different densities, so a cut-down plastic bottle full of one fertilizer will not contain the same weight as the same measure full of another type of fertilizer.

For those with access to the internet, a tool (the OFRA fertilizer calibration tool) is available at CABI-ASHC website (www. africasoilhealth.cabi.org ). This tool enables the user to calibrate any circular or rectangular container filled with a range of fertilizers.

For smaller amounts of fertilizer the plastic lids from water bottles or beer or soda metal crown cork bottle-tops[1] may be suitable.

| Fertilizer type | Weight of fertilizer (g) per metal beer or soda bottle-top full |
|---|---|
| TSP | 7 |
| Urea | 4 |
| MOP | 6 |

1 The standard metal crown cork bottle-top has a 2.8 cm diameter and a depth of 0.5 cm, giving a volume of 3 ml (3 cm3). It has 21 ‘teeth’.

**The right time**: Apply fertilizer when soil is moist, during the rainy seasons.

To minimise losses, N fertilizer (such as urea) should be applied in two split applications –at the beginning and then in the middle of the rainy season (about 2 months after the first application).

It is not necessary to apply phosphate (such as TSP) and potash (such as MOP) fertilizers in split applications as they are released more slowly.

**The right place**: Fertilizer should be applied over the soil surface where feeder roots are found.

Most of the roots of banana are found in the surface of the soil up to a depth of 30 cm and a dense network of roots develops directly under the mulch.

Like banana, coffee has a shallow root system with most of the feeder roots found in the surface 20 cm of soil. Most of the roots of coffee bushes are found around 60-90 cm for Arabica and 150 cm for Robusta from the base of each coffee bush.

Remove trash on the surface where fertilizer is to be applied, apply fertilizer and then replace the trash.

For young banana mats, make a furrow about 30 cm from the mat. Place fertilizer in the furrow and cover with soil. If the mother plant has a bunch approaching maturity, apply fertilizer to the daughter and granddaughter. Do not work the fertilizer into the soil using a hoe as you may damage roots of the crops.

For fertilizer N (e.g. urea) in young coffee plants, apply under the leaf canopy, extending up to 20 cm beyond the drip-line.

*Mature banana-coffee systems*
In mature banana–coffee intercrops it is not practicable to target fertilizers to one or other of the two crops; by the time the system has started to yield, root systems of both crops will have formed an overlapping, continuous web of roots.

**The right fertilizer products at the right rate:** Table 5 provides ranges of fertilizer suitable for applying to mature banana-coffee systems trees during the first year and in the second and subsequent years. The lower end of the range is most suited to relatively fertile soils and the higher end for soils which are relatively low fertility; for example, if a farmer has a relatively fertile soil, for first year banana-Arabica, 370 kg urea and 110 kg TSP and 635 kg MOP per hectare would be suitable. Recommended amounts of fertilizer are given as both kg per hectare and the equivalent expressed as kg per 100 coffee trees – farmers often know how many coffee trees they have and may find this easier than kg per hectare.

**Table 5: Suggested fertilizer application rates for mature banana-coffee systems in sub-Saharan Africa**

| Year | Crop | Target yield increase tonnes/hectare (green bean for coffee) | | Urea | and TSP | and MOP |
|---|---|---|---|---|---|---|
| | | Banana | Coffee | kg per hectare (kg per area with 100 coffee trees) | | |
| First year | Banana-Arabica | 10 | 0.5 | 370-435 (17-20) | 110-140 (5-6) | 635-770 (29-35) |
| | Banana-Robusta | 10 | 1 | 500-610 (45-55) | 130-175 (12-16) | 750-920 (68-83) |
| Second year onwards | Banana-Arabica | 10 | 0.5 | 220-250 (10-11) | 55-75 (2-3) | 385-450 (17-20) |
| | Banana-Robusta | 10 | 1 | 300-350 (27-31) | 75-100 (7-9) | 470-550 (42-50) |

**The right time**: Apply fertilizer when soil is moist, during the rainy seasons. To minimise losses, fertilizer N application should be applied in two split applications – for example at the beginning and then in the middle of the rainy season (about 2 months after the first application). It is not necessary to apply phosphate and potash fertilizers in split applications as they are released more slowly.

**The right place**: Fertilizer should be applied over the soil surface where feeder roots are found. Remove trash on the surface where fertilizer is to be

applied, apply fertilizer and then replace the trash. The best approach is to broadcast fertilizers over the soil surface under the banana–coffee system.

**Shade and fertilizer use**
There is also a strong interaction between shade and fertilizer use in coffee production.

Where soil fertility is poor, coffee grown under shade often yields better and is a more resilient system (i.e. plantation life is longer and production more stable) than coffee grown without shade.

If shade is too dense the yield potential of coffee is reduced and the coffee will respond poorly to fertilizer. Adding fertilizers to coffee that is heavily shaded is not recommended because the increase in coffee yield may not be sufficient to cover the investment in fertilizer. Reducing the number of bananas to reduce shade can improve the benefits of fertilizer in such fields.

**Additional tips on fertilizer use**
To get good and profitable response from fertilizers, competition for fertilizer should be reduced by careful weeding, water should be managed well and there should also be appropriate investments in pest and disease management.

**Africa Soil Health Consortium – improving soil fertility, improving food production, improving livelihoods**

ASHC works with initiatives in sub-Saharan Africa to encourage the uptake of integrated soil fertility management (ISFM) practices. It does this primarily by supporting the development of down to earth information and materials designed to improve understanding of ISFM approaches.

ASHC works through multidisciplinary teams including soil scientists and experts on cropping systems; communication specialists, technical writers and editors; economists; monitoring and evaluation and gender specialists. This approach is helping the ASHC to facilitate the production of innovative, practical information resources.

ASHC defines ISFM as: A set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs and improved germplasm combined with the knowledge on how to adapt these practices to local conditions, aiming at optimizing agronomic use efficiency of the applied nutrients and improving crop productivity. All inputs need to be managed following sound agronomic and economic principles.

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