



# Practical guide

## *Soil fertility and fertilizers*

### *Summary*

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## About AfricaRice and Afrique-learning

### **AfricaRice:**

AfricaRice is a leading pan-African rice research organization committed to improving livelihoods in Africa through solid science and effective partnerships. AfricaRice is a research center of CGIAR, which is part of a global research partnership on future food security. It is also an intergovernmental association of African member countries. Today, it has 30 member countries. The mission of AfricaRice is to contribute to poverty reduction and food security in Africa through research, development and partnership activities, aimed at increasing the productivity and profitability of the rice sector so as to guarantee the sustainability of the agricultural environment.

### **Afrique-Learning:**

Afrique-learning is a Beninese cooperative which creates and manages vocational e-learning courses specially designed for African youth. Courses are tailor-made in collaboration with experts in the field with the aim of producing interactive, illustrated, interesting and easy-to-study courses that provide the student with important information in simple and appropriate language. Learning is done independently at the student's own pace, it is assessed and a course certificate is attained following a final test. Courses are available on computer, smartphone or android tablet. They only require a very modest bandwidth and are therefore within the reach of students. Registration and classes are free.

## Acknowledgements

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## Source of images and tables

- [1] Fairhurst, T. (ed) (2015) Handbook for Integrated Soil Fertility Management. African Consortium for Soil Health, Nairobi.
- [2] Illustration produced by EUDOX BÉATITUDES
- [3] Photos provided by AfricaRice
- [4] <https://fr.wikipedia.org/wiki/Fumier#/media/Fichier:Hestem%C3%B8j.jpg>
- [5] Photo provided by Dr. Ayewa Tchatchibara
- [6] [https://upload.wikimedia.org/wikipedia/commons/thumb/5/56/Calcium\\_oxide\\_powder.JPG/250px-Calcium\\_oxide\\_powder.JPG](https://upload.wikimedia.org/wikipedia/commons/thumb/5/56/Calcium_oxide_powder.JPG/250px-Calcium_oxide_powder.JPG)
- [7] [https://fr.wikipedia.org/wiki/Soja#/media/Fichier:Plante\\_de\\_Soja\\_-\\_Feuilles\\_et\\_fruits.jpg](https://fr.wikipedia.org/wiki/Soja#/media/Fichier:Plante_de_Soja_-_Feuilles_et_fruits.jpg)
- [8] [https://fr.wikipedia.org/wiki/Arachide#/media/Fichier:Peanut\\_9417.jpg](https://fr.wikipedia.org/wiki/Arachide#/media/Fichier:Peanut_9417.jpg)
- [9] [https://fr.wikipedia.org/wiki/Pois\\_d%27Angole#/media/Fichier:Cajanus\\_cajan.jpg](https://fr.wikipedia.org/wiki/Pois_d%27Angole#/media/Fichier:Cajanus_cajan.jpg)
- [10] Photo provided by Hendrik Pöhl

# I. Assessment of soil fertility

- To assess soil fertility, researchers and extension agents carry out observations on the environment and tests on soil samples
- Farmers can make these observations to assess soil fertility :

- the dominant vegetation
- the presence of a particular soil fauna
- color as an indicator of organic matter content
- soil texture, assessed by touch
- the appearance of crops, from sowing to maturity
- crop yields, based on past harvests
- the appearance of crops during periods of drought and
- the facility or difficulty of working the soil during field preparation



Assessment of soil texture [1]

- Symptoms visible on plant leaves can also indicate high nutrient requirements due to poor soil quality



Soybean plant showing symptoms of K deficiency [1]



Young maize plant showing symptoms of P deficiency [1]

## II. Organic inputs and mineral fertilizers

### Examples of organic inputs

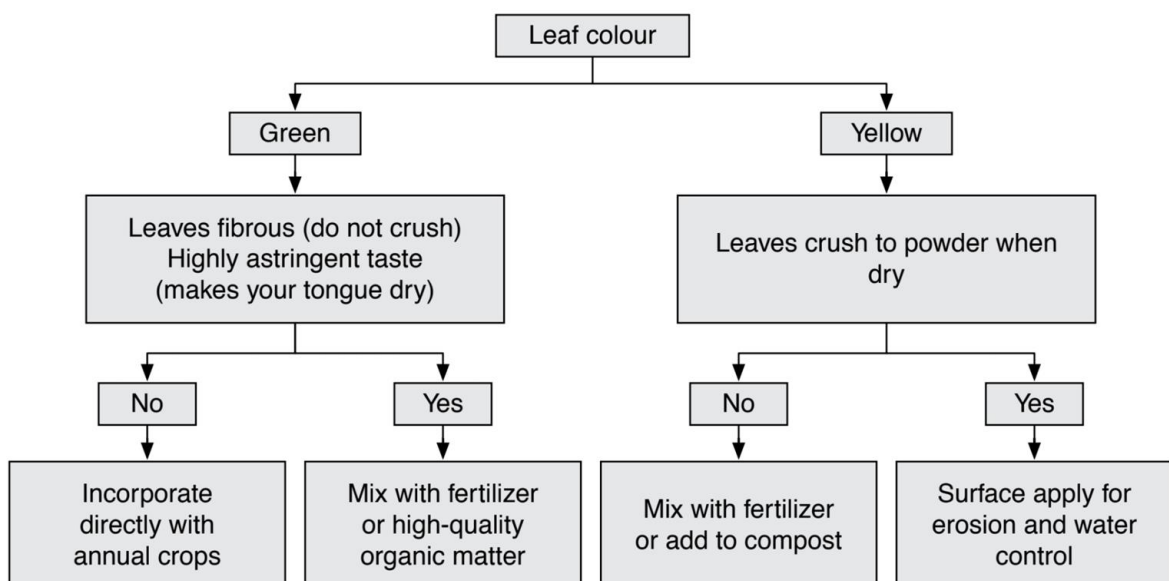
- Poultry manure (provides nitrogen)
- Cow dung
- Biochar
- Plant residues



Manure for fertilizing the field [4]

### Classification of plant residues

- There are various uses for the rest of the plants as an organic fertilizer
- Depending on the nature of the leaves, they are suitable either for direct addition to the crop, for compost or simply as a cover to protect the soil against erosion
- It is possible to classify the rest of the plants according to their use
- A simple grading method is based on the color, fiber content and taste of the materials (see the following graph)



Categorization of organic matter: example of leaves and their use [1]



## *Guidelines for the use of mineral fertilizers*

- Use approved mineral fertilizers
- The recommended doses as well as the conditions of use must be scrupulously respected at the risk of obtaining a result contrary to that expected
- The combined use of mineral fertilizers and organic resources is the best approach
- Applying mineral fertilizers without maintaining or increasing organic matter may reduce productivity and increase soil acidity
- Lime should be used to correct the acidity of the soil
  - sandy soils need small amounts of lime to correct acidity
  - large amounts of lime are needed in highly acidic clay soils
- Ash can also be used as a “natural mineral fertilizer”



Fertilizer application [1]

## *Conservation agriculture*

- Conservation Agriculture is a cropping system that can prevent the loss of arable land while regenerating degraded soils
- This is a set of techniques aimed at better long-term profitability by reducing the need for inputs (fertilizers, plant protection products and fuel) without prohibiting them
- These techniques are based on three pillars:
  - reduction or even elimination of tillage, and especially plowing
  - diversification of cultivated plant species
  - permanent soil cover by crops, companion plants and plant cover

## III. Other soil fertility management practices

### *Legume cultivation*

- It's then necessary to make rotation between a cereal and a legume to enrich the soil with nitrogen
- This way of enriching the soil reduces the need for mineral fertilizers
- Some examples of legumes:
  - peas, beans, cowpeas, pigeon peas, peanuts, soybeans, Mucuna.
- As cover crops these plants also prevent soil erosion



Soybean [7]



Peanuts [8]



Pigeon peas [9]

### Cultural practices

- Proper soil preparation is a prerequisite for good crop establishment
- The sowing date should be chosen based on knowledge of the start of the rainy season
- Spacing must be appropriate and consideration must be given to the distances between seed rows, between plants and the number of plants per pocket
- Seeds must be planted at the correct depth
- Weeds must be removed in time to increase yield
- Weed before applying the top-dressed fertilizer so that the nutrients support the growth of the crops and not the weeds
- In intensive rice cultivation, crop rotations including legumes such as cowpeas, soybeans or peanuts improve yield



Soil preparation [2]



Crop rotation with soybeans [10]

## IV. Fertilizer use

### *Choice of fertilizer*

- The choice of the fertilizer depends on the crop, current and past manure use, as well as soil properties and climatic conditions
- We saw that the use of organic resource and mineral fertilizers, in a sustainable manner, is the best approach
- It is very important to fully understand the soil characteristics and plants' requirements, before deciding which fertilizers to use and how to use them
  - agricultural technicians and extension agents can help you carry out this analysis of your soils
- Using the right fertilizers, and in the right quantities, allows the farmer to avoid wasting his investment, to avoid polluting the environment and to increase his yield



A fertilizer seller who offers NPK [1]

### *Dose and time of application*

- For a good dose of fertilizer, the amount of fertilizer applied must be matched to the crop's requirements and this depends on the cropping system and location of the farm
- Applying too much fertilizer causes waste of nutrients not used by the crop and contaminates the environment
- Application of very small amount of fertilizers does not achieve full yield and crop quality, which also produces less crop residue
- It is very important to choose the right time to apply fertilizer: it is important to ensure that nutrients are available when the crops need them.
- The application of basal fertilizer is made at the time of sowing or just after transplanting to provide the necessary nutrients for the start of crop growth
- In rice cultivation, it is advisable to add basal fertilizer on the day of sowing or transplanting and to supplement with two applications of cover fertilizer at the tillering phase and at panicle initiation



Fertilizer dosed using a capsule [1]

## *General conditions of application*

- The choice of application method depends on labor, crop and soil
- The field must be weeded and make sure that there are no more weeds before applying the fertilizer otherwise it will be consumed by the weeds
- Fertilizer should be applied when the soil is a little wet so that it can be easily used by the plant
- Applying fertilizer when the soil is dry increases losses due to the volatilization of nitrogen as a gas

## *Main methods of application*

1. Broadcasting:
  - a. fertilizers are applied uniformly to the soil surface
  - b. it is done either before sowing or in the standing crop (top dressings spreading)
2. Banding:
  - a. fertilizers are placed in a band at a depth of 5-8 cm below the soil surface
  - b. seeds are planted above the covered fertilizer
3. Spot application: fertilizers are applied in small amounts at the time of sowing in each plant hill with the seed or near each plant during growth
4. Deep placement: slow-release nitrogen fertilizers are placed in the soil of flooded fields

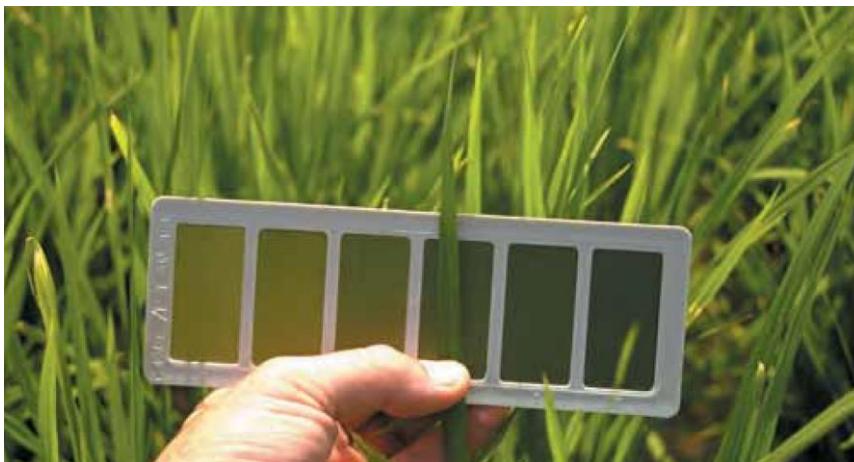


Banding [1]



## Recommendations

- To improve the fertilizer application schedule, you need to:
  - apply fertilizer at the right time when there is sufficient moisture in the soil
  - apply P and K fertilizers when sowing
  - apply nitrogen fertilizers by split applications according to the growth stage of the crop: the use of leaf colour charts to compare with the leaves will allow the application of top-dressed fertilizer N for rice at the right time of its growth.
- To improve the application method of fertilizers, it is necessary to:
  - apply fertilizer in a way that reduces losses through leaching and volatilization
  - apply fertilizers in the soil near the root zone of the crop.
- Promote sustainable fertilization by:
  - applying P and K fertilizers with nitrogen fertilizers (N) in a sustainable application
  - reducing the amount of nitrogen fertilizer (N) applied and increasing the amount of K and P fertilizer applied
  - applying a large amount of P fertilizer at once to restore the soil's P content



The color palettes for the leaves can be used to improve the application schedule of nitrogenous cover fertilizer for rice [1]

## V. Examples of fertilizer application for rice cultivation

### *Application de NPK pour le riz*

- Apply the fertilizer on the day of sowing and on the seed rows
- Use the specific NPK rice fertilizer at a rate of 200 kg / ha
- You can also use NPK for cotton at the same dose
- Avoid a NPK basal fertilizer to the soil when leveling because this creates an overgrowth of weeds which will consume the nutrients that were intended for the rice



The application of NPK in rice cultivation [2]

### *Urea application for rice*

- Urea provides nitrogen (N)
- For the application, drain water from the lockers if water level exceeds 5 cm
- In rice cultivation, two applications of urea are recommended:
  - a first application between 30 and 35 days and a second between 45 and 50 days for varieties with a short cycle (90 - 100 days)
  - a first application between 45 and 50 days and a second between 60 and 65 days for varieties with a long cycle (110 - 120 days)
- The application technique depends on the amount of water in the inland valley:
  - if you can evacuate water, apply urea in row
  - if evacuation is not possible, apply urea using broadcast application



The application of urea in rice cultivation [2]