The Fundamentals of Agronomy and Agroecology

Key Lessons from the Training Conducted at Ceffel in Madagascar

Soil health and fertility | **Plant nutrition** | Plant health

1 Key Factors

A well-nourished plant is naturally **stronger against external aggressions** and **will grow better**. However, each crop has **specific nutritional needs**, making it essential to **adjust nutrition practices accordingly**.

Poorly managed nutrition can affect plant and soil health (leaf burning, deficiencies, soil acidification), ultimately having negative effects on yields and income.

On the other hand, **appropriate nutrition improves farm productivity** through higher yields while avoiding excessive expenditure.

2 Agronomic Considerations

Plants absorb nutrients in a mineral form. The conversion to an assimilable form almost always requires the action of soil life. A healthy soil will therefore always perform better, ensuring the crop is nourished at the right time and in the right dose. This is true even for chemical fertilizers (urea or others): **the soil is the foundation.**

Use of mineral fertilizers

- Primary source: **Fertilizers**
- Secondary source: **Soil**

Agroecological approach

- Primary source: **Soil**
- Secondary source: **Organic fertilizers**

Depending on their composition, **organic fertilizers release their nutrients over a more or less long period of time**: the more woody/fibrous elements the fertilizer contains, the longer the nutrients will take to become available to the plants, and they will have more of an amending effect than a fertilizing/growth-boosting effect.

Different types of fertilizer = different effects

Very short-term effect	Short-term effect	Medium/long-term effect
• Inorganic fertilizers • The mineral part of certain organic fertilizers *Slurry, liquid compost, Tithonia tea*	• Rapidly degradable crop residues (previous legume crops, legume cover crop) • Rapidly degradable organic fertilizers *Poultry droppings, legume residues*	• Woody/lignified crop residues (straw, stalks, non-legume plant cover crop) • Organic amendments • The humified part of organic fertilizers *Mature composts, raw manure*

Mineral part (directly absorbable)

Rapidly usable organic part

More stable organic part (slow degradation)

- **Soil pH** is the priority because when acidity is too high, nutrients will not be properly absorbed.
- In general, nitrogen contributes to **plant growth**. Plants have the highest need of nitrogen when biomass is at its maximum (e.g., flowering), so **nitrogen fertilizer application must be anticipated**.
- Phosphorus (root development) and potassium (photosynthesis, resistance to water stress) should be added at sowing, and then for demanding crops (vegetables) for which the reproductive phase is very sensitive, an additional input (P, K) before/at flowering is often useful.
- Nitrogen is easily mobile in the soil, unlike phosphorus and potassium. Excessive nitrogen input under very wet conditions will cause it to leach.
- In contrast, phosphorus and potassium will be more easily absorbed if they are located close to the plants, hence the importance of a well-developed root system (and therefore a good soil structure).

3 Observe and Diagnose

Study the soil and exchange with the farmer:

- Soil texture: sausage test and/or jar test
- Structure
- Soil pH level
- Biological activity

Study the root system of the plants:

- Appearance of roots
- Root development

→ Example in legumes: are there pink active nodules?

Study the condition of the plant:

- Monitor symptoms of deficiencies on the plant

→ Identification of the limiting factor: Liebig's law of the minimum

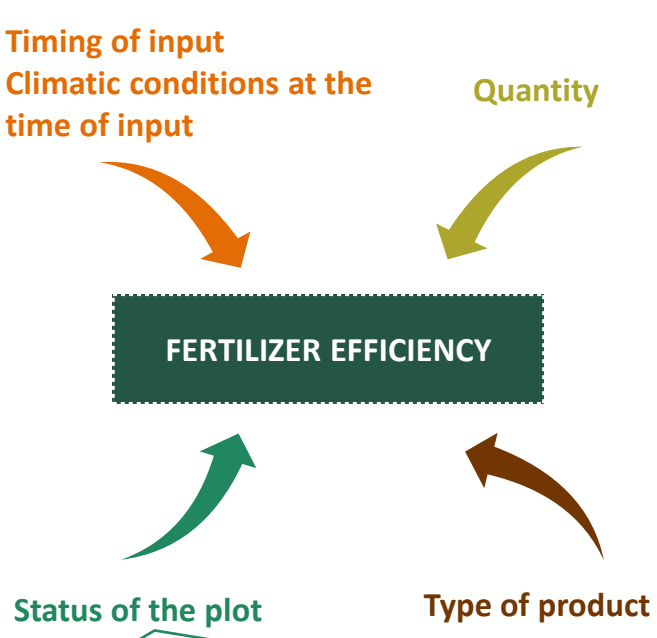
Observe and question farming practices, levels of production and productivity:

- **Sources of nutrients:** Are the inputs from inorganic fertilizers, compost, animal manure or other source?
- **Nutrients availability:** Will they be available in the short, medium, or long term?
- **Production in previous years:** Has it been satisfactory, stable or declining?
- **Crop nutrient requirements:** These vary according to the crop, growth stage and production level. Ideally, local references should be used.
- **Weed presence:** What types are observed in the field? Are they indicators of specific soil texture or structure? What is their impact on yield, and how are they managed?
- **Soil moisture conditions:** How are they before applying nitrogen fertilizers? What climatic events (heavy rain, drought) have occurred?

Needs	=	Supplies
The needs of plants depend on the crop and the production objective.		*nitrogen supplied by inorganic fertilizers (assimilated mainly through the soil)* *nitrogen fixed by legumes* *nitrogen supplied by the soil (mineralization of soil organic matter, residues, organic fertilizers)*

4 Main Strategies

- **Observe and understand** your soil (in a group or independently): comparison is key.
- **Conduct regular soil tests** and propose/apply the appropriate recommendations.
- **Correct soil acidity** through liming to allow plants to absorb nutrients such as phosphorus, whose assimilation is blocked below a **pH** of 5.5.
- **Add organic matter** (compost, manure, etc.) while considering C/N ratios to match needs (enriched, rapid or slow-degradation compost).
- **Implement crop rotation,** taking into account the complementarity in nutrient requirements and rooting systems of different species.
- **Apply nutrients according to the 4R law:** the Right product, at the Right dose, at the Right time, and in the Right place (positioning).
- **Manage weeds appropriately and in a timely manner:** before planting and before fertilizer application, when the weeds are young.



- Quantity of **N already present**
- Factor(s) **limiting the mineralization of organic fertilizers**
- Periods of need in nutrients
- Soil structure
- Grass cover ...

5 Key Elements to Consider

The Importance of soil health:

Good soil health is a fundamental prerequisite for proper plant nutrition: texture, structure, pH, organic matter.

Refer to: Soil Health and Fertility sheet

Use organic amendments before inorganic fertilizers:

- Slower action, but lasting impact on soil structure and nutrient supply.
- More economical in the long term.

⚠ Avoid applying fresh manure too close to sowing. Prefer mature or composted manure: it destroys any potential weed seeds and harmful bacteria.

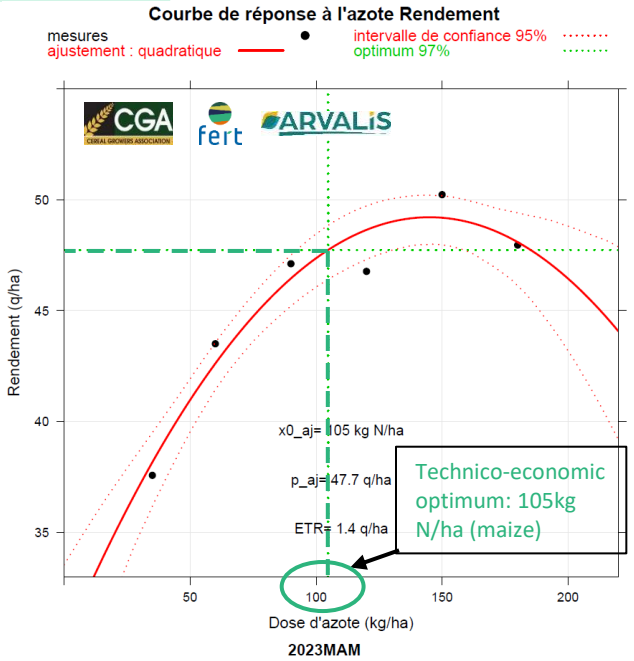
Understand fertilizer composition:

- Adapt the nutrient inputs for plants based on the nutrient content of the fertilizers applied.
- Read fertilizer labels to understand the content and quantity of nutrients being added. The figures indicate the nitrogen, phosphorus and potassium content in kg (always in this order) per 100kg.
  In the example on the right: 18kg N, 46kg of P and 0kg of K per 100kg of this fertilizer
- What matters is not the product name (e.g., CAN, DAP), but its nutrient content.

More fertilizer does not mean more yield:

Beyond a certain nitrogen dose, yields plateau or even decrease.

The technico-economic optimum lies slightly below the maximum yield.



Vigilance regarding foliar fertilizers

- Macronutrients, especially nitrogen, are poorly absorbed by leaves, unlike micronutrients/trace elements, and the quantities applied are minimal compared to the plants' needs.
- With the exception of vegetables, applying foliar fertilizer in dry weather is ineffective: the stomata are closed, so the fertilizer runs off the leaf without penetrating it, and the cost is significantly higher.

To maximize effectiveness

- Apply inorganic fertilizer as closely as possible to crop needs (timing and localized application).
- Quickly incorporate the inorganic fertilizer.
- Split the applications.

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