Savoir faire

Bernard Dubos, Xavier Bonneau
and Albert Flori



# Oil Palm Fertilization Guide

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We also thank Peter Biggins, longtime translator for tropical oil crops researches, for the translation of the French version into English.

# Preface

It is a real pleasure to write a few words to introduce this book. Even if you are not an agronomist, you are bound to feel more knowledgeable after reading this guide. Its originality lies in its not being a long list of recipes. I think the authors' intention is to make everyone aware that oil palm nutrition is a science, and to set up a fruitful dialogue between plantation agronomists and managers, and scientists.

As a breeder, the interaction between plant material and nutrition is one of my constant concerns. Variation in the mineral signature of the leaflets of different varieties is a fact, and agronomists will have to pay more attention to changes in mineral contents (leaflet, rachis), rather than just to a "critical level". The authors do not forget that managing soil fertility also means managing the determinants of soil structure, such as organic matter content, or the soil exchange capacity, which are factors that go hand-in-hand with mineral nutrition. Of course, the reader will gain a better understanding of positive or negative interactions, or competition for uptake between minerals. However, things remain complex and oil palm nutrition specialists will continue to be of great help.

The current commodity price crisis, which follows on from the one in 2011/12, and will be followed by others, challenges us on nutritional efficiency. One of the first keys is how plant nutrition is managed. Numerous publications have shown that nutrition methods based on the "reimbursement" of stocks, exports and leaching of minerals generally lead to an overestimation of real needs. The method presented here is based on long-term experiments and helps to determine actual needs. Such an experimental network should accompany any oil palm nutrition policy. It should not be seen as a constraint but as an opportunity to manage oil palm nutrition in a sustainable and efficient way based on scientific facts.

Another challenge is to define an economic optimum. Fertiliser prices vary, storms are followed by calmer periods, but the trend is towards higher nutrition costs because world stocks are sometimes limited, or prices are strongly linked to energy. Moreover, oil palm responds to fertilisers over the long term: today's nutrition will have an impact on yields in the years to come. There is true know-how to be developed to mitigate costs and adopt long-term nutrition policies that are in line with long-term economic trends.

The approach described here might seem to be reserved exclusively for large plantation companies. In fact, it seems quite possible to make general recommendations for smallholders based on fairly large agronomic units (soils, general environmental conditions) that can be implemented by State Agricultural Development Services.

I should like to sincerely thank the authors for their efforts to sum up decades of experiments and analyses in a short, easy-to-read book that provides an understanding of the underlying evidence-based decision-making approach to managing oil palm nutrition.

*Tristan Durand-Gasselin,*
*senior oil palm breeder and CEO of PalmElit,*
*a Cirad subsidiary specializing in the development*
*and diffusion of sustainable oil palm varieties.*

# Introduction: context and purpose of this guide

With yields 4 to 10-fold higher than other oil crops, and its competitive production costs, the oil palm has become the world's leading source of vegetable fats and oils. These advantages explain the steady increase in areas planted to oil palm to meet growing world demand, especially in emerging and developing countries (Southeast Asia, China, India, Africa).

However, an increase in oil palm areas leads to environmental and social conflicts each time it destroys tropical forests and biodiversity.

Better yields through genetic improvement and appropriate farming practices help to satisfy demand while limiting deforestation risks. Fertilizing oil palm plantations (either inorganic or organic fertilizers) has long been considered a major way of increasing productivity: indeed, it was considered that nutrients should never be a limiting factor and high fertilizer application rates were sometimes recommended (box 1 and figure 1). Today, best environment-friendly practices, and the attention paid to agricultural input costs, call for rational fertilization based on a precise diagnosis of requirements in each cultivated plot.

A full oil palm life cycle involves a continuous increase in frond length up to 12 years old, and in stem growth, with the ultimate height determining the end of the palm's working life and the programming of a new cycle. These specifics have to be taken into account for fertilization decisions over the different periods of the life cycle (figure 2).

Backed up by sound technical information from many years (40) of multi-site trials, this guide is designed to help agronomists in charge of designing fertilization programmes. For each plantation, it proposes fertilizer recommendations that take into account the specificities of oil palm plantings, based on an interpretation of leaf analysis (LA) results (box 2).

Contents depend on the fertilizers applied, but also on other factors (climate, soils, planting material).

This guide proposes to fine-tune the leaf analysis tool by improving each stage of its operation:
– by standardizing whatever can be, i.e., the sampling procedure, sampling period, choice of laboratory,
– by making pragmatic and non-systematic choices for structuring plantations in "leaf sampling units", and the positions of the palms to be sampled,
– by interpreting leaf analyses according to optimum contents determined by fertilization trials conducted in the same soil, climate and planting material context.

### Box 1. Fertilization and productivity factors

Fertilization is just one of the productivity factors that determine oil palm yields (figure 1). For a given planting material, bunch (FFB) production is mostly determined by photosynthesis efficiency, which can be limited by the water balance (soil dryness reducing gas exchanges) and insolation (insufficient sunlight, particularly when water supplies are satisfactory). Foliage status is also an important factor, with severe defoliation by insects affecting the production of photosynthates (sugars resulting from photosynthesis).

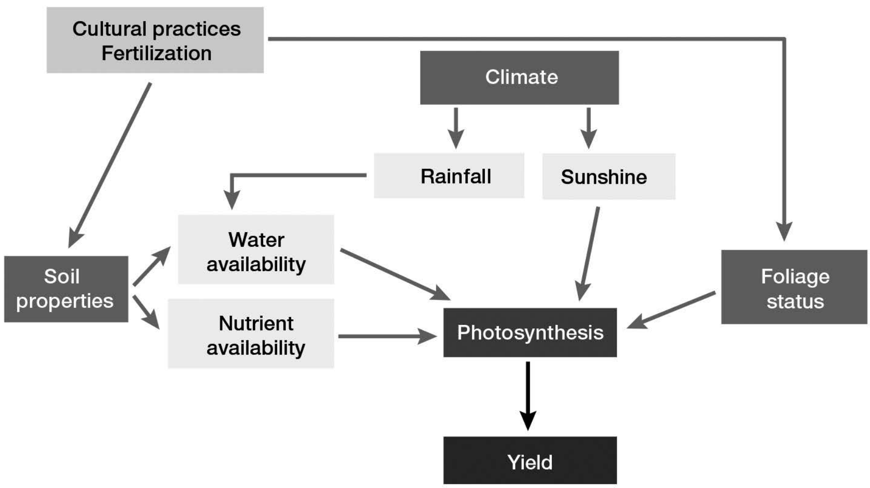


**Figure 1.** Simplified diagram of oil palm bunch yield build-up

> Agricultural practices, including fertilization, along with soil properties, climate data and foliage status affect photosynthesis, hence bunch production. This diagram does not take into account the response time of around two years separating stress periods and their effects on yields.

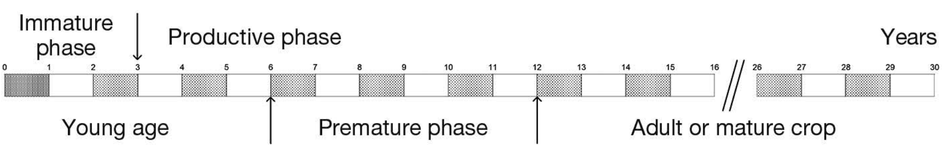


**Figure 2.** Standard diagram of an oil palm working life cycle

> After planting in the field, the first 30 to 36 months are the immature phase, where small bunches are not harvested for economic reasons. Young palms are fertilized according to a schedule specific to each plantation. The productive phase begins after three years with the start of harvesting, which coincides with the start of stem growth. Leaf samples are taken during the productive phase to guide fertilization in the plots. A good indicator is frond length and biomass. At the young age up to six years, growth is highly sustained until the tips of horizontal fronds reach those of neighbouring palms. Frond length increases moderately between six and 12 years, in the so-called premature phase. From 12 years onwards, it is considered that frond biomass is stable: this is the adult (or mature) period, which lasts up to the point where it is no longer possible to harvest bunches once the stem reaches 12 metres in height, usually between 27 and 30 years old. Bunch yields usually reach maximum in the premature phase. They remain stable during the adult period, sometimes with a slight decrease after 20 years.

These well thought-out and standardized protocols guarantee quality analysis results to manage areas that are as uniform as possible, and they provide a relevant interpretation of leaf contents for making fertilizer recommendations.

The guide explains how to compile fertilizer schedules based on fertilization trial results and why they need to be validated by monitoring responses in plantation leaf sampling units.

It also explains why fertilizing oil palm plantations must not be construed as a simple need to adjust a factor that might be limiting. In fact, trials help to define application rates that maintain or raise leaf contents, and they help to fix thresholds beyond which it becomes pointless applying fertilizers. Providing tools for precise and environment-friendly fertilization contributes to society's sustainability expectations. It involves seeking an economic and environmental optimization of fertilization practices.

**Box 2. Leaf analysis: a much-used tool**

Leaf analyses have been widely used since 1950 to fertilize large agro-industrial estates. Mineral nutrient contents are expressed as a function of the dry matter (dm) weight of leaflets (as a % for N, P, K, Ca, Mg, Cl, S, in parts per million (ppm) for trace elements). Analysis results are compared to reference values, so that fertilization can be adjusted each year according to the division of the plantation into leaf sampling units (LSU). Leaf analysis is a much-used decision-support tool, but it is considered an empirical method. Nonetheless, it remains very widely employed due to its simple use and the quality of the information it provides.

**Table 1.** Content ranges commonly measured in the leaflets of rank 17 fronds

| Nutrient | Symbol | Contents |
|---|---|---|
| Nitrogen | N | 2.40 - 3.00% dm |
| Phosphorus | P | 0.15 - 0.17% dm |
| Potassium | K | 0.70 - 1.00% dm |
| Calcium | Ca | 0.25 - 0.70% dm |
| Magnesium | Ca | 0.18 - 0.22% dm |
| Chlorine | Cl | 0.40 - 0.70% dm |
| Sulphur | S | 0.18 - 0.23% dm |
| Boron | B | 8 - 15 ppm |
| Copper | Cu | 5 - 15 ppm |
| Zinc | Zn | 15 - 40 ppm |
| Manganese | Mn | 100 - 600 ppm |