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Popular myths around soil fertility management in sub-Saharan Africa

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Abstract

The aim of this paper is to demystify some of the popular myths related to tropical soil fertility management that have gained hold in the development community and are often being promulgated by NGO's and development agencies in the tropics. Negative nutrient balances at farm scale or at larger scales are very often presented as proof that soil fertility is at stake in SSA. However, nutrient balances at plot and farm section scale are not always negative. In areas with large nutrient stocks, short-term nutrient mining is fully acceptable. Fertilizer use continues to face considerable controversy in SSA. In this paper, we demonstrate that fertilizers rarely damage the soil; that fertilizers are being used in SSA, often with favourable value-to-cost ratios; and that fertilizers do not cause eutrophication in SSA. Rock phosphates are abundantly present in SSA but most are poorly soluble. Adding these phosphates to compost heaps does not enhance the short-term availability of their P. Although organic inputs are essential soil amendments besides fertilizer, organic inputs alone cannot sustain crop production due to limitations in their quality and availability. Organic resources can also potentially stimulate harmful pests and diseases. Legumes are often advocated as important sources of organic matter but not all legumes fix nitrogen, require inoculation, or are a source of free nitrogen, as even green manures require land and labour. Certain grain legumes with high N harvest indices do not improve soil fertility, but remove net amounts of N from the soil. These myths need correction if we are to harness the role of science in the overall goal of assisting farmers to address the acute problems of poor soil fertility for smallholder farmers in SSA.

Keywords: Biological N fixation; Fertilizer; Legumes; Nutrient balances; Organic resources; Rock phosphate

1. Introduction

Soil fertility in Africa is at stake! (Smaling et al., 1997). It is widely acknowledged that poor soil fertility is the principal constraint to production in smallholder farming in Africa. Many development projects run by Government agencies and non-governmental organizations (NGO's) address the problem of poor soil fertility, but often on the basis of incorrect assumptions. We, as authors of this paper, are soil scientists actively involved in both research and debate concerning the problems of soil fertility in Africa. We often visit development projects and are involved in discussions with farmers, development workers, politicians and policy makers, both those belonging to donor agencies and the recipient countries. Arguments repeatedly come to the fore in these discussions that are not supported by our research experience or by the scientific literature.

The aim of this paper is to demystify some of the popular myths related to tropical soil fertility management that have gained hold in the development community and are often being promulgated by NGO's and development agencies in the tropics. We focused on myths in the context of the Integrated Soil Fertility Management (ISFM) paradigm, currently adapted by the science community dealing with tropical soil fertility management. ISFM has been defined as 'The development of adoptable and sustainable soil management practices that integrate the biological, chemical,

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physical, social, cultural and economic processes that regulate soil fertility' (CIAT et al., 2001). Technically, ISFM advocates the utilization of locally available resources, the combined application of organic resources and fertilizer, and enhancement of the use efficiency of both inputs (Vanlauwe, 2004). We do not claim complete understanding of all of the issues nor do we claim to cover all misconceptions related to appropriate soil fertility management. Rather we feel that many decisions made on investment in initiatives that are intended to address the problem of soil fertility are actually based on mis-information. Misunderstandings need correction if we are to achieve the overall goal of assisting farmers to address the acute problems of poor soil fertility for smallholder farmers in Africa. Other topical and contested issues, such as the dangers of nitrate in drinking water (see Addiscott and Benjamin, 2000; Addiscott, 2005) are predominantly problems of affluent countries and will not be considered here.

2. Myths surrounding nutrient balances

Nutrient balance studies of smallholder farming systems in Africa have received considerable attention since the papers of Smaling, Stoorvogel and colleagues appeared in the early 1990's (Stoorvogel and Smaling, 1990; Smaling et al., 1993; Stoorvogel et al., 1993). Whilst these studies have been highly influential in raising attention to the problem of soil fertility in Africa, nutrient balances are often been mis-interpreted and misused.

2.1. Myth: nutrient balances are always negative

Even in resource-limited smallholder agriculture not all fields are continuously mined; some fields have very positive nutrient balances, usually through concentration of nutrients from other parts of the farm (Scoones, 2001; Tittonell et al., 2005). This arises from the diversity of plot management, as most organic resources and mineral fertilizers are used on the home gardens and infields, and rarely on the outfields further away from the homestead. The development of gradients of declining soil fertility with distance from the homestead may not be a deliberate form of management, but probably an inevitable consequence of the limited availability of cattle manure and other nutrient resources. Preferential application of nutrients to the infields and home gardens ensures good crop yields in these limited areas, and saves labour in terms of the distance the nutrients are transported.

2.2. Myth: nutrient balances can be used to derive crop fertilizer requirements

During an emergency meeting concerning food shortages in Malawi in the mid 1990s, an international scientist presented a study based on agricultural statistics at national scale. The aim of the meeting was to consider approaches to increasing agricultural production and the need for fertilizers was of particular concern. The scientist had analysed crop exports from Malawi and concluded that the largest problem in Malawi was potassium because when crop exports of K were compared with fertilizer inputs the balance was highly negative. Conversely, a series of more than 1600 nutrient response trials conducted throughout Malawi failed to find evidence for the need for K fertilizers anywhere in the country (MPTF, 1997). A similar conclusion was reached in a study based on widespread soil sampling and analysis who found no evidence for K deficiencies (Matabwa and Wendt, 1993). The reason that the soils in Malawi can support yields without additional K fertilizers is that the K stocks in the soils are large and can provide sufficient K for crop growth. In Europe, some soils contain sufficient K to sustain production for hundreds of years (Holmqvist et al., 2003).

This example demonstrates that soil nutrient mining is a sensible option for farmers. As long as farmers do not see responses in crop growth and yield when fertilizers are applied they would be foolish to invest in importing extra nutrients! If stocks of available nutrients are high, yields of 3 t ha^{-1} of maize can be obtained without added fertilizers (Esilaba et al., 2001). Of course sustained nutrient removal will eventually mean that nutrients have to be replaced, but the speed with which nutrients are depleted depends on the yields of crops and the amounts of nutrients removed in relation to the nutrient stocks. The major conclusion is that nutrient balances cannot be used to indicate sustainability or to indicate fertilizer requirements without consideration of the stocks of the nutrients in the soil. Moreover, if a nutrient-balance study indicates a deficit (i.e. an overall removal of nutrients) then simply supplying that amount of nutrients in the form of mineral fertilizers will not lead to a balanced nutrient budget. Particularly in the case of N, the fertilizers added will be subject to unwanted losses, largely through leaching.

3. Myths surrounding fertilizers

Many studies in SSA have demonstrated the close links between increased crop production per unit area and fertilizer use. It is therefore surprising that this route for improving crop production has received stronger headwinds in SSA than elsewhere in the world, especially as crops react to fertilizer in SSA as they do elsewhere in the world.

3.1. Myth: fertilizers damage the soil

We quote from a recent MSc examination paper at a university in Northern Europe concerning the management of soil fertility in Africa: "*Using artificial fertilizers on a large scale in Africa will mean that smallholder farmers become dependent on countries in the North. Fertilizers destroy the soil structure and soil life. Yields will decline*