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## Assessing, Understanding and Targeting of Non-Responsiveness to Inorganic Fertilisers Across Heterogeneous Smallholder Farming Landscapes in Sub-Saharan Africa for Improved Maize and Soybean Production

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### Abstract

Using improved varieties and inorganic fertilisers by smallholder farmers in sub-Saharan Africa has led to doubling, even tripling of crop productivity in many cases. Yet some reports show failures to reach effective increases crop yield increases upon using inorganic fertilisers in some soils, here called ‘non-responsiveness’. Little research has investigated occurrence and causes of non-responsiveness to fertilisers. This study assessed the frequency of non-responsiveness, underlying biogeochemical causes, and management interventions to improve fertiliser efficiency in smallholder farming landscapes of DR Congo, Kenya, Tanzania and Nigeria.

Responses of maize and soybean to inorganic fertilisers varied greatly between the farming landscapes, irrespective of growing season. Inputs of NPK to maize crops failed to increase grain yield by 1 ton ha<sup>-1</sup> from non-fertilised controls in 24 % of studied farmlands in Kenya, 46 % of farms in Tanzania, a staggering 74 % of farmlands in DR Congo and 79 % of farms in Nigeria. For soybean inoculated with Rhizobia, inputs of P and K failed to increase yield by 300 kg ha<sup>-1</sup> from non-fertilised controls in 54 % of the studied farms in Kenya, 61 % in Tanzania, 30 % in DR Congo and a staggering 91 % of farms in Nigeria. Crop non-responsiveness across all farming landscapes tended to be greater in seasons with low or erratic rainfall, and increase with time after land conversions. Improved management with broadcasting agricultural lime at 3 tons ha<sup>-1</sup> decreased the frequency of non-responsiveness for both test crops by 15 to 20 % in the Kenya site, whereas in the DR Congo site only a 5 % reduction in non-responsiveness was reached. Inputs of secondary and micro nutrients decreased non-responsiveness in maize with 20 % in the Tanzania site. At the Nigeria site, spot application of manure at 2 ton ha<sup>-1</sup> and deep tillage brought down the frequency of non-responsiveness in maize by 45 % and by 27 % in soybean. Exhaustive laboratory and field kit analyses were carried out on soil texture, mineralogy, extractable nutrients, P sorption, exchangeable Al, CEC, fungal-bacterial community composition, root mycorrhizal colonisation, pest and disease scores, and plant nutrient deficiencies to understand their individual contributions to crop productivity and (non-)responsiveness to fertiliser inputs.

**Keywords:** Fertiliser efficiency, integrated soil fertility management, smallholder grain and legume cropping, soil and plant health