

Selective application of farmyard manure improves rice yields in phosphorus-deficit paddies in Sub-Saharan Africa

Rice demand in Sub-Saharan Africa is increasing rapidly, yet rice productivity remains low, averaging only 2.3 t ha⁻¹. Smallholder farmers in the region often cultivate rice under severe soil fertility constraints, particularly in strongly weathered soils where phosphorus (P) deficiency is common. Although mineral fertilizers can increase yields, their high cost and limited accessibility often restrict their use. Under such conditions, farmyard manure (FYM), which can be produced locally from livestock manure and plant residues, represents an important on-farm resource. Previous studies have suggested that organic amendments such as FYM can improve P availability by mobilizing soil-bound P, but evidence from farmers' fields showing how FYM effectiveness varies with soil P status has remained limited.

To address this gap, field experiments were conducted for four consecutive cropping seasons in four farmers' rice paddies in the central highlands of Madagascar that differed in available soil P. FYM was applied annually at 10 t ha⁻¹ (fresh weight), corresponding to the level commonly used by local farmers. Yield responses to FYM were substantially greater in P-deficit paddies than in non-deficit paddies. Over four seasons, the average yield gain with FYM reached 1.5 t ha⁻¹ in P-deficit paddies, compared with only 0.4 t ha⁻¹ in non-deficit paddies (Fig. 1). The cumulative effect of repeated FYM application also became larger over time, and the greatest response was observed when FYM was combined with nitrogen (N) fertilizer, with yield gains of up to 3.1 t ha⁻¹. In P-deficit paddies, the average yield gain achieved with FYM alone corresponded to 77% of that obtained with inorganic N and P fertilizer (Fig. 2). In addition, a synthesis of 13 field trials from six countries in Sub-Saharan Africa showed the same general pattern, confirming that FYM application is consistently more effective under P-deficit conditions (Fig. 3).

These results demonstrate that the agronomic effectiveness of FYM depends strongly on soil P status and that P-deficit paddies should be prioritized when FYM resources are limited. The findings provide a scientific basis for the selective use of FYM in rice systems of Sub-Saharan Africa. By targeting FYM to fields where it is most effective, farmers can make more efficient use of locally available organic resources, improve rice productivity, and reduce reliance on costly mineral fertilizers.

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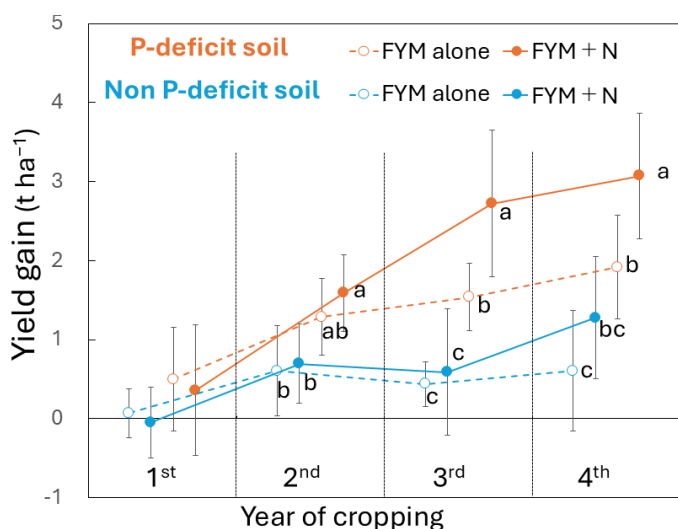


Fig. 1. Yield response to repeated application of farmyard manure (FYM)

Means of two P-deficit and two non-P-deficit paddies. P-deficit soils were defined as Bray-II P ≤ 12 mg P kg⁻¹ (Dobermann, 2000). Yield increase was calculated relative to the no-fertilizer control. FYM consisted of cattle manure, plant residues, and rice straw. Nitrogen fertilizer was applied as urea at 80 kg N ha⁻¹. Different letters indicate significant differences (Tukey's test, $p < 0.05$).

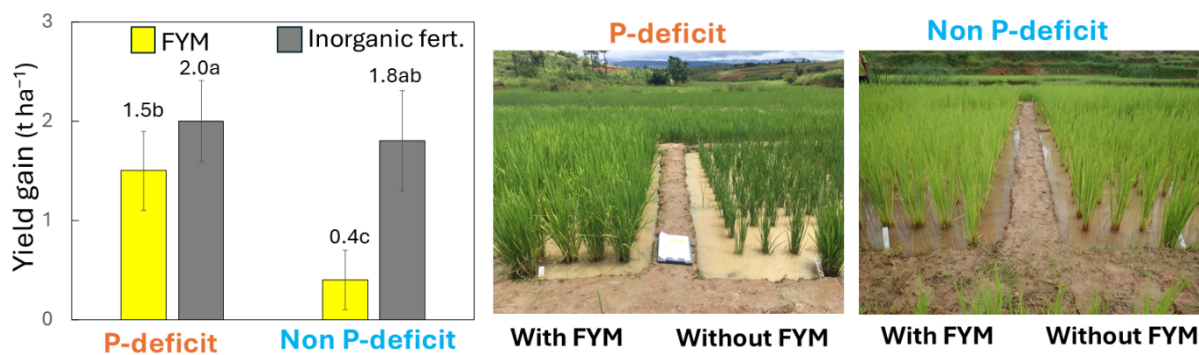


Fig. 2. Yield increase with farmyard manure (FYM) and mineral fertilizer

Mean yield increase over four cropping seasons in two P-deficit and two non-P-deficit paddies, relative to the no-fertilizer control. Mineral fertilizer was applied at 80 kg N ha⁻¹ and 50 kg P₂O₅ ha⁻¹ each season. The photo (right) compares plant growth at 70 days after transplanting under no-mineral-fertilizer conditions, with and without FYM. Error bars indicate standard deviations. Different letters indicate significant differences (Tukey's test, $p < 0.05$).

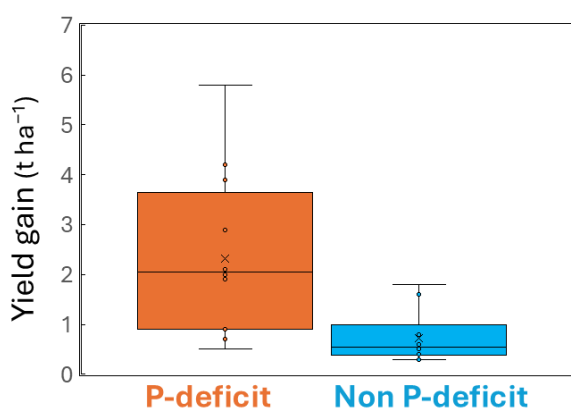


Fig. 3. Yield increase with farmyard manure (FYM) in Sub-Saharan Africa

Yield increase in 13 field trials (eight P-deficit and five non-P-deficit paddies) conducted without mineral fertilizer. Yield increase was calculated as the yield difference between FYM-applied and no-FYM plots. Paddies were classified by available soil P following Dobermann (2000). FYM materials, composition, and application rates differed among trials. The difference between groups was significant (t -test, $p < 0.01$).

Reference: Asai et al. (2025) *Field Crops Research* 23: 590 – 601. © Elsevier 2025
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