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Spatial Variability of Indigenous Nutrient Supply for N, P and K and Impact on Fertilizer Strategies for Irrigated Rice in the West African Sahel

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Abstract

Even with optimal crop management, spatial variability of indigenous nutrient supplies combined with uniform fertilizer recommendations for large regions can cause low fertilizer efficiency, low productivity of expensive inputs and high losses to the environment. Substantial efficiency increases were achieved with site-specific nutrient management approaches, but the relative importance of different components (field, region or season specific precision) remained unclear. We conducted a field trial to investigate small-scale variability of indigenous nutrient supply of N (INS) P (IPS) and K (IKS) on a three hectare farm and used the field data in subsequent simulation scenarios to analyze the agro-economic effects of fertilizer management with different precision levels.

Spatial variability of soil characteristics and of IS on the small area analyzed was high and covered a large part of the variability found in regional studies within the Senegal river valley. INS ranged from 19 to 78 kg N ha^{-1}, IPS ranged from 11 to 45 kg P ha^{-1}, and IKS ranged from 70 to 150 kg K ha^{-1}. This caused yield ranges of 2.2 to 6.0 Mg ha^{-1} in N omission plots, of 4.1 to 9.8 Mg ha^{-1} in P omission plots, and of 5.3 to 9.6 Mg ha^{-1} in K omission plots. The highest yield in the fully fertilized treatment was 11.6 Mg ha^{-1}. Simulated potential yield was 11.8 Mg ha^{-1}. Simulations of fertilizer management scenarios were based on observed IS, observed average recovery rates, and potential yield. Scenarios ranged from high precision and season specific fertilizer doses to the existing regional recommendation for average seasonal yield potentials. Highest precision and an economically optimal target yield resulted in an average yield of 9.6 Mg ha^{-1} compared to 7.5 Mg ha^{-1} for the uniform recommendation. Net benefit from fertilizer use dropped by 19 %. Highest losses of optimal net benefit were related to non-season specific recommendations (12 %), whereas lower spatial precision contributed only 7 % to the net benefit loss. We concluded that uniform regional recommendations for agro-ecological zones modified by crop diagnostics offer the best opportunities to optimize fertilizer efficiency and net benefits of fertilizer use in intensive irrigated rice.

Keywords: Indigenous nutrient supply, irrigated rice, site specific nutrient management, spatial variability, West Africa

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