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Nitrogen-Use-Efficiency in Maize-Based Farming Systems in Malawi: A Simulation and Meta-Analysis of Literature

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Abstract

Degraded soils and poor soil fertility are the major constraints limiting agricultural production in small-scale farming systems of sub-Saharan Africa. Nitrogen-use-efficiency (NUE) in maize-based farming systems remains low as a consequence of unrealistic nitrogen fertiliser application recommendations, inherently low and highly variable soil fertility and resource limited agronomic management. By examining literature, the efficiency of on-farm N fertiliser response was evaluated by a meta-analysis of commonly reported agronomic use efficiencies of N fertiliser applications (N-AE) for Malawi. The N-AE is defined as the increase in grain yield per unit of fertiliser N applied. Therefore it is an important value to analyse and compare present management systems. Other than poor access to fertiliser and lack of resources to purchase fertiliser, inappropriate management practices and application rates have resulted in lower N-AE than expected. Commonly reported N-AE from on-farm evaluations was highest in moderate amounts of N fertiliser (20–30 kg N ha^{-1}) and ranged between 15 and 28 kg grain per kg N applied. In experimental trials N-AE values varied between 17 and 24, and simulated values between 19 and 25 kg grain per kg N applied. As soil fertility is generally low, additional phosphorus (P) fertilisation of 18 kg ha^{-1} significantly increased the N-AE in the experimental trials to a maximum of 65 kg grain per kg N applied. Overall, N applications exceeding 30 kg ha^{-1} seemed to result in decreasing N-AE. This paper also describes how the crop simulation models, such as the Agricultural Production System Simulator (APSIM), could simulate N and P fertilisation strategies under scenarios with varying planting time and density, fertiliser application rate and timing as well as weed management. This allowed the major drivers influencing on-farm NUE to be identified leading to more robust nutrient strategies for sustainable intensification.

Keywords: Agronomic N use efficiency, APSIM, farming systems, maize, Malawi

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