Assessing the Accuracy of the NUTMON Model on Agricultural Nitrogen Balances in Sub-Saharan Africa

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Closer analysis of the agricultural interventions implemented in Sub-Saharan African (SSA) villages, including those by the Millennium Villages Project (MVP), will need to be conducted in order to assess their environmental impacts. In particular, the shift of the nitrogen balance through increased use of fertilizers will alter local soil, water, and air quality. The NUTMON model was designed as a survey-based agricultural management system. NUTMON operates using farmer-reported information (cropping data, treatments, labor, etc.) along with physical parameters (soil data, rainfall, etc.). NUTMON uses literature-derived equations and pedo-transfer functions to simulate the flow of nutrients into and out of the farming system. The model has been used in many papers to analyze the agricultural practices of farms in SSA, many of which have identified net negative nutrient budgets in African farming systems. However, the reliance on the same set of pedo-transfer functions in many of these studies has been criticized for resulting in inaccurate estimations of nutrient losses. We employed NUTMON to simulate how increasing fertilizer inputs in a maize cropping system in Western Kenya may affect losses of nitrogen to the environment. We were also able to conduct a preliminary evaluation of the model's accuracy regarding N budgets using field observations. NUTMON calculated net negative nitrogen balances for all fertilizer treatments (ranging from 0 to 200 kg N/ha), suggesting that continued farming will deplete soil nutrient pools. However, NUTMON appeared to substantially overestimate gaseous N2O emissions by 15 to 25 times in comparison to observed losses. When compared to leaching losses, NUTMON underestimated by 1.5 to 5 times the observed values. The negative N balance NUTMON results are consistent with many others across SSA, implying that the current agricultural practices in SSA are unsustainable for the long term and will lead to increasing declines in soil fertility. However, the model does appear to be overestimating N losses from the system. The increased use of fertilizer in SSA may have a less pronounced effect on the local environment than would be expected from the NUTMON model.