Deutscher Tropentag, October 8-10, 2003, Göttingen

"Technological and Institutional Innovations
for Sustainable Rural Development"

Effect of Land Use on Soil N Dynamics at Watershed Scale in West Africa

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Abstract

With demographic growth, land use in inland valley landscape in the humid zone of West Africa has recently been intensified. Bottomlands are opened for lowland rice cultivation while the adjacent slopes are increasingly being cleared for food crops. The extent of slope use is likely to intensify water and nitrogen fluxes and thus to differentially impact on soil fertility and crop productivity. A quantitative understanding of the water and N dynamics with intensified land use is hypothesized to improve the spatial targeting of technical options aiming at conserving soil fertility and maximizing water/nutrients use efficiency. A three-year study was conducted in a 130 hectare model watershed in the forest-savannah transition zone close to Bouake (Côte d'Ivoire). One half of the valley bottom was used for permanent lowland rice cultivation (8 ha). The land use of the slopes was gradually increased from natural vegetation in 2000 to 5 % (2001) and 10 % (2002) being converted into maize fields. Seasonal dynamics of soil moisture and water discharge as well as of mineral soil nitrogen and plant N uptake in the entire watershed were monitored. With the onset of the rainy season, a peak of soil N_{min} of 70 kg N ha^{-1} was observed (Birch effect). The disappearance of nitrate N from the uplands coincided with a N_2O emission peak in the lowlands. This effect was most pronounced in newly opened land and its extent increased with the share of upland area cleared. By the onset of the main cropping period and the beginning uptake and immobilization of N in the biomass of crops, substantial amounts of soil N have been lost. Lowland rice does not seem to effectively use the early season influx of nitrate from cleared upland fields. Hence, the conservation of buffer strips of natural vegetation in the hydromorphic valley fringe to avoid nitrate seepage into the lowland and/or the use of pre-rice nitrate catch crops in the lowland to temporarily immobilize N in a growing biomass may enhance native soil N use efficiency. The effectiveness of various technical options under different land use scenarios will be discussed.

Keywords: Land use, N-dynamics, rice, West Africa

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