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Modelling Landscape Effects of Agroforestry on Watershed- and Ecosystem Functions in a Small Watershed in Nicaragua

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Abstract

Slash and burn agriculture without fallow in maize-bean systems of NW Nicaragua has led to severe soil degradation through soil organic matter (SOM) mining and erosion. SOM loss is aggravated through cattle grazing on harvested fields. Improved maize-bean rotation systems have been developed, namely Slashing & Mulching of Crop Residues (CR), which is current farmers' practice, and the Quesungual Slash & Mulch Agroforestry System (QSMAS), an agroforestry system based on permanent soil cover, absence of burning, minimal soil disturbance and efficient fertiliser use. Native trees conserved in cropping fields are heavily pruned twice a year, before maize and bean sowing to provide light, soil cover and litter. While CR and QSMAS do not differ in maize and bean yields, QSMAS is known for its potential to create important ecosystem functions (ground cover, nutrient cycling and soil moisture) through the provision of a mulch layer. However, fodder scarcity during dry seasons compels farmers to expand livestock grazing on QSMAS and CR plots, potentially counteracting systems benefits. Thus, a study using the spatially explicit and dynamic process based Land Use Change Impact Assessment model (LUCIA) was implemented to compare two QSMAS designs, which differed in species composition and pruning intensities, as well as the CR system regarding their effects on watershed functions under different management options.

Two landscape-scale questions were investigated: a) Potential effects of QSMAS and CR expansion into forests on watershed SOC stocks. Twenty year simulations suggest a strong depletion of landscape level carbon stocks under CR expansion (+2.4 %) but being less severe under QSMAS expansion (+0.5 %), compared to current baseline without any land use change. b) Recycling of dung depositions in corrals near homesteads as manure for vegetable production instead of current disposal into streams. Simulations suggest that matter fluxes off the plots, e.g. loss of SOM through grazing on agricultural land, could be partly compensated, once manure was returned to the farm system. Cash crops, like watermelons could profit from the additional organic inputs.

The study depicts scenarios, which possibly help in identifying key mechanisms to conserve watershed- and ecosystem services.

Keywords: Agroforestry, dynamic modelling, ecosystem services, Nicaragua, Quesungual

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