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Modelling Catchment-Scale Erosion Mitigation Potential of Legume-Led Crop Rotations under Varying Slope Lengths

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Abstract

The highland regions of western Kenya are domicile to agricultural activities, but simultaneously constitute a major hot-spot for water-driven soil erosion due to erosive rainfall, intensive land cultivation, and steep topography. In the smallholder-dominated Rongo sub-county land tenure is traditionally organised in strips in slope direction and predominant maize plots are ploughed downhill. Slope length and degree have pronounced influence on surface run-off and soil erosion. The question arises, can legume rotation systems placed in strategic landscape positions minimise effects of slope length on soil degradation and nutrient loss emanating from severe run-off? This study applied biophysical field measurements and modelling to answer this question. The study aimed at improving knowledge of the impact of slope length on farmer selected legume-based cropping systems on sustainability of the production base (soil fertility), environment (run-off, soil loss) and food production. We measured run-off and soil loss on bounded plots of: a) 12×4 m RCBD under different legume cover (*Mucuna pruriens*, *Lablab purpureus*, *Arachis hypogaea*) planted in pure stand and *Zea mays*/ *Phaseolus vulgaris* intercrop (farmers' practice) with/ without *Calliandra calothyrsus* leaf mulch; b) 20, 60, and 84 m slopes under *Zea mays*/ *Phaseolus vulgaris* intercrop at different locations in the landscape. Experimental data were employed for modelling in a 20 km^2 watershed using the landscape model LUCIA (Land Use Change Impact Assessment). LUCIA was validated with one-year field datasets on run-off and soil loss. Field results showed that *Mucuna pruriens* proved most effective in controlling run-off and soil loss after the Calliandra mulch treatment, whereas, highest run-off and soil loss was observed under farmers' practice and *Lablab purpureus*. Larger soil loss was observed on the longer slope lengths. Model scenarios include rotation of cover legumes with maize intercropped with grain legumes, placement of cover legumes in strips at upper and middle slope positions, expansion of legume cultivation area at the landscape-scale to explore the impact of slope length on soil degradation and food security. In-depth stakeholder discussions on model outputs will focus on identification of sustainable conservation measures and implementation pathways.

Keywords: Landscape, legume, simulation, slope length, smallholder, soil erosion

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