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Landscape-level sustainable land use optimisation of Lake Chamo catchment, southern Ethiopia

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Abstract

Forest Landscape Restoration (FLR) doesn't take place on degraded lands only. When implementing on agricultural mosaic landscape, it is crucial to investigate which option is economically feasible, environmentally viable and socially acceptable. This study analyses the optimal land use to maximise the economic benefit while the carbon storage potential of the land use systems and employment potential is not compromised. The study was conducted in the Lake Chamo catchment of Ethiopia as a widespread practice of cultivating crops on steep slopes is common in the catchment, resulting in diminished productivity and posing challenges to environmental sustainability. A total of 128 households were surveyed to estimate parameters of the model, profit per unit of land use, labour requirement per land use practice, and total land use of the existing land use system practices namely, annual crop, perennial crop, agroforestry, and woodlot. We also sampled 101 plots to estimate the carbon storage of the land uses. Linear programming was applied to optimise the land use profit in three alternative scenarios. Scenario one, focusing on commercialisation, aims to maximise profit constrained by total available land size. Scenario two, Policy-bound commercialisation, pursues the same objective as the first but incorporates land suitability classification based on the country's rural land regulations. The third scenario, policy and employment-bound commercialisation mirrored the objective of the first two but also included minimum employment requirement criteria. The optimisation aimed to maintain natural land cover while redistributing the land uses influenced by human activity. The result from scenario one, focusing solely on profit led to dedicating all land to agroforestry. However, considering ecological and social factors reduced annual and perennial cropland by 21 % and 2.7 % respectively, while increasing woodlot area by 26 %. Among the different agroforestry practices that are found in the area, combining fruit trees with annual crops was found to optimise profit, labour and carbon balance. Promoting agroforestry-based FLR options on the landscape has great potential for success as it aligns with the community's main goal of maximising profits and can be readily embraced and expanded.

Keywords: Forest landscape restoration, linear-programming, optimisation, sustainability