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## Can Smallholder Farmers in the Sahel Benefit from Payments for Carbon Sequestration?

EIKE LUEDELING, HENRY NEUFELDT

*World Agroforestry Centre (ICRAF), Kenya*

### Abstract

Carbon finance is often cited as a potential source of income for smallholder farmers in developing countries, yet for many environments, data on carbon scheme viability are unavailable. To close this knowledge gap for West African parkland systems, we used ecological niche modelling and a literature review to estimate potential carbon stocks in newly established parklands for 19 climate scenarios. Based on resulting carbon sequestration rates, the economic viability of hypothetical carbon finance schemes was evaluated using a carbon finance business model. Climate analogue analysis was used to illustrate the climatic trajectory of selected current parkland locations.

For a hypothetical scenario, in which parklands were assumed to cover the maximum area possible, potential carbon stocks in agricultural land were estimated at 1,284 Tg C, compared to 725 Tg C for a ‘treeless agriculture’ scenario under baseline climate conditions. Carbon sequestration potentials were much lower for most future scenarios. Due to low annual sequestration rates of about 0.4 Mg per hectare, profitability of carbon sequestration schemes was low. Even when large numbers of farmers (>40,000) participated, projects targeting small farms (2 ha of new parklands per farm) required high carbon prices of >US\$ 11 t<sup>-1</sup>, even for the most viable payment scheme tested. For farmers, profitability was always low, even at higher carbon prices. Under optimistic assumptions, net present values (perceived value over a project lifespan of 25 years) of carbon sequestration were below 50 USD for all project schemes targeting small farmers. It seems unlikely that Sahelian farmers will engage in such activities, unless substantial non-carbon benefits are also derived. Climate analogue locations for three sites in Senegal, Mali and Niger indicated decreasing climatic suitability for parkland agroforests for most future scenarios. In this light, carbon sequestration does not seem like a promising source of income for project managers or farmers in the Sahel. However, parkland agroforests have been shown to benefit farmers through diversifying farm incomes, improving soil fertility and providing positive microclimatic effects. The prospects of agroforestry to provide adaptation benefits to farmers are thus much greater than their potential to generate substantial cash flows through carbon finance mechanisms.

**Keywords:** Agroforestry, carbon sequestration, climate analogue analysis, climate change, ecological niche modelling, maximum entropy (MaxEnt), parklands