



Tropentag, September 16-18, 2026, hybrid conference

“Towards multi-functional agro-ecosystems
promoting climate resilient futures”

Economic-environmental evaluation of silvopastoral systems in Colombia

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Abstract

Colombia's cattle sector holds considerable socioeconomic importance but also generates significant environmental impacts, particularly due to greenhouse gas (GHG) emissions. However, it can also support climate change mitigation through the adoption of low-emission cattle systems like silvopastoral systems (SPS). Compared to monoculture pastures (M), SPS can maintain cattle productivity while increasing GHG removal and reduction. Nevertheless, high initial investment costs limit SPS adoption, underscoring the need to assess their profitability and promote financial mechanisms that support their implementation. The objective of this contribution was to evaluate the economic-environmental performance of an SPS and compare it with M in cattle fattening systems in Colombia. Experimental plots were established using the grasses *Urochloa brizantha* cv. Toledo and U. hybrid cv. Talismán alone (M) and in association with the tree *Leucaena diversifolia* (SPS). Plots were grazed by crossbred cattle (Brahman × Simmental × Charolais). A financial analysis compared the profitability of both systems, considering revenues from cattle sales and the economic valuation of carbon sequestration and methane emission reduction. Cattle revenues were estimated from liveweight gain measured at the beginning and end of the trial. Carbon sequestration was determined from carbon stocks in woody biomass and Soil Organic Carbon, which were derived from a vegetation inventory and soil sampling. Methane emission reduction was estimated using emission factors for both diet systems. The market price method was used to value these ecosystem services. Results indicate that the SPS achieved higher animal productivity, reaching higher profitability indicators compared to M, even without considering revenues from Payments for Ecosystem Services (PES). Moreover, SPS achieved an estimated carbon sequestration of 4 tCO₂eq ha⁻¹ year⁻¹ and methane reduction of 0.5 tCO₂eq ha⁻¹ year⁻¹, representing a potential additional income of approximately 45 USD ha⁻¹ year⁻¹. The GHG reductions and removals associated with the SPS not only contribute to climate change mitigation, but also generated additional income through PES. This further improved the SPS's financial indicators, diversified income sources, and reduced economic risk. These findings indicate that SPS are a profitable alternative and that PES can be a key mechanism to promote their adoption and scale up low-emission cattle systems.

Keywords: Carbon markets, low-emissions cattle systems, market price method, methane emission reduction, payment for ecosystem services

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