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A farm-level financial framework for sustainable cattle intensification: Evidence from Colombia's Altillanura

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Abstract

Sustainable intensification is promoted as a pathway to reconcile productivity growth with environmental sustainability in cattle systems, particularly in frontier regions where low-productivity ranching coexists with land degradation and climate pressures. In Colombia's Altillanura, these challenges are especially acute, yet farm-level evidence on the private economic performance of integrated intensification packages remains scarce. This study presents a pilot economic assessment designed to validate a financial evaluation framework using two case studies in Puerto Gaitán, Meta: Alejandrera and Altamira. Since 2021, both farms have implemented a sustainable intensification package promoted by the NGO GANSO, including improved pastures, silvopastoral components, good cattle practices, water infrastructure, and technical assistance. These interventions aim to increase stocking rates and animal productivity through enhanced forage availability and more efficient resource use. The primary contribution of the study is methodological. A discounted cash flow framework is applied to assess private profitability over the 2022–2031 period, complemented by a Monte Carlo simulation (5,000 iterations) to explicitly incorporate uncertainty. Four standard financial indicators are estimated: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost ratio, and Payback Period. Uncertainty is introduced through key variables, including stocking rate, daily weight gain, cattle prices, and the opportunity cost of capital. Two financing scenarios are evaluated: a baseline reflecting standard agricultural credit conditions in Colombia, and a preferential scenario incorporating subsidised lending terms. This design enables both estimation of expected returns and assessment of downside risk and key profitability drivers. Results show that the framework produces economically consistent and policy-relevant insights at the farm level. Under baseline financing, NPV reaches US$43,634 (Alejandrera) and US$25,156 (Altamira), with IRRs of 61 % and 41 %, respectively, and benefit-cost ratios above one. Preferential financing substantially improves returns. The probability of negative NPV is zero in Alejandrera and remains low in Altamira, while sensitivity analysis identifies daily weight gain and cattle prices as the main drivers of profitability. Although illustrative rather than generalisable, these findings demonstrate the usefulness of the framework for structuring farm-level evidence, quantifying uncertainty, and informing adoption decisions. Future research should scale this approach and integrate environmental and ecosystem service valuation.

Keywords: Discounted cash flow, financial analysis, livestock economics, Monte Carlo simulation, silvopastoral systems, sustainable intensification

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