



Tropentag, September 11-13, 2024, hybrid conference

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## Long-term economic viability of different coffee intercropping systems in the central highlands of Vietnam

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### Abstract

The Central Highlands of Vietnam (CHV) is the biggest Robusta coffee (*Coffea canephora*) producing region globally. However, climatic and market volatilities are increasingly challenging the predominantly smallholder farmers. While coffee monocropping is the dominant production system, different types of intercropping systems have become an interesting way to manage risks and increase land use efficiency. Yet, the widespread adoption remains limited due to costly establishment investment barriers.

This study conducts detailed Net Present Value (NPV) analyses of spatially targeted coffee-based farming system interventions aimed at increasing income resilience and reducing pressure on crop area expansion into forests across four districts in Lam Dong and Dak Nong of the CHV. Consultation with stakeholder groups and household surveys with 510 representative coffee farmers were conducted in 2023, followed by validation workshops with local stakeholders to verify crop yields, prices, input costs, etc. NPV models were specified to predict the economic performance of four stakeholder-prioritised coffee intercropping systems with durian, macadamia, persimmon, or *Michelia tonkinensis* A. Chev over a 25-year horizon against coffee monocropping. NPV and annual farm cash-flows were modeled using Monte Carlo simulations considering uncertainties in Gompertz tree yield curves, pest and disease risks, establishment and operational costs, crop prices, and discount rates.

Simulation and sensitivity analyses highlight positive farm-level profitability of intercropping interventions relative to coffee monoculture. When revenue and cost uncertainties are considered, at least 60% of farm households would earn positive economic benefits over 25 years. While the initial cost of establishing intercropped trees is a significant barrier, the optimal timing of planting within the coffee lifecycle can mitigate negative farm cash-flow effects. Already marginal and ethnic minority households may require financial support to maintain community living standards over the model period. Importantly, diversification through intercropping improves economic resilience by buffering periods of low coffee prices and the cost of coffee replanting. This paper shows that sustainable, nature-based interventions can yield positive economic outcomes for farmers while increasing land use efficiency, thus lowering pressures of natural forest encroachment. Access to financial services with favourable terms may be needed for broad uptake of sustainable coffee practices in Vietnam.

**Keywords:** Deforestation-free coffee, ethnic minorities, household livelihood, Monte Carlo simulations, net present value analysis, tree intercropping