Tropentag, September 16-18, 2026, hybrid conference

"Towards multi-functional agro-ecosystems
promoting climate resilient futures"

Baseline complexity shapes multifunctional trade-offs in latin american tropical crops

Mario Contreras-Fleury[1], Andrea Cecilia Sánchez Bogado[2], Hugo-Enrique Reyes-Aldana[3], Sarah Jones[4]

[1] *The Alliance of Bioversity International & CIAT , Multifunctional Landscapes Research Lever, France*
[2] *The Alliance of Bioversity International & CIAT , Multifunctional Landscapes Research Lever,*
[3] *Johann Heinrich von Thünen Institut, Inst. of Biodiversity, Germany*
[4] *The Alliance of Bioversity International & CIAT, Multifunctional Landscapes, France*

Abstract

Biodiversity loss and agricultural production are frequently cast as competing demands, yet the conditions under which trade-offs are severe, moderate, or avoidable remain poorly quantified at scale. This meta-analysis examines 1,940 pairwise management comparisons drawn from 88 studies across coffee, cacao, and banana systems in Latin America, three crops that differ systematically in their baseline system complexity and thus constitute a natural experiment for testing whether starting conditions shape trade-off severity.

We propose the Baseline Intensity Hypothesis: the degree to which diversifying management generates a biodiversity-yield trade-off depends on how intensified or simplified the reference system already is. Crops with complex baselines (coffee and cacao in multi-strata agroforests) show limited room for gain; crops with simplified baselines (banana in monocultures) retain recovery potential. Consistent with this hypothesis, trade-off outcomes differ markedly by crop: 82 % of coffee comparisons and 75 % of cacao comparisons fall in the biodiversity-gain/yield-loss quadrant, while banana comparisons split more evenly (50 % trade-off, 50 % win-win). Abundance benefits span multiple taxa—arthropods (+41 %), vertebrates (+44 %), and plants (+64 %)—but management pathway matters: input reduction most favours arthropods, while shade management most benefits non-crop vegetation.

Applying a yield-threshold framework (<15 % loss as the safe-transition criterion), seven transitions qualify as safe pathways, including three win-wins: cacao monoculture to low-complexity agroforestry (+52 % biodiversity, +21 % yield), banana conventional to lower inputs (+54 %, +11 %), and banana monoculture to cover crops (+526 %, +1.5 %). Total carbon storage emerges as a universal win-win: all nine measured transitions record carbon gains of 41–305 %. Economic outcomes remain a persistent challenge: income reductions are recorded across all five measured transitions (3–37 % decline), requiring financial support mechanisms to be viable at farm level.

These findings provide a quantitative basis for crop-differentiated management recommendations. The Baseline Intensity Hypothesis suggests that conservation policy and agroecological transition strategies should not apply uniform guidance across crop types but instead account for where a given system sits on the intensification gradient, a distinction with direct consequences for resource allocation, subsidy design, and voluntary certification schemes across Latin American agricultural landscapes.

Contact Address: Mario Contreras-Fleury, The Alliance of Bioversity International & CIAT , Multifunctional Landscapes Research Lever, 3 place romain rolland, 34070 Montpellier, France, e-mail: m.contreras@cgiar.org

Keywords: Agricultural inputs, Agroecology, agroforestry, banana, biodiversity, biodiversity-productivity frontier, cacao, carbon capture, coffee, Latin America, meta-analysis, monoculture, safe transitions, shade, trade-offs, tropical agriculture