Agroforestry and biodiversity

Reference 9

De Beenhouwer, M; Aerts, R; Honnay, O. 2013 A global meta-analysis of the biodiversity and ecosystem service benefits of coffee and cacao agroforestry. Agriculture, Ecosystems and Environment 175: 1– 7. doi: 10.1016/j.agee.2013.05.003

Background and objective

Agroforestry has long been proposed as a more sustainable agricultural system, conserving biodiversity and ecosystem services, while providing significant local livelihood. In this context, cacao and coffee agroforestry is often regarded as more compatible with conservation of ecosystem integrity than cacao and coffee plantations. Using metaanalytical techniques and mixed models on data from 74 studies conducted across Africa, Latin America and Asia, a global quantitative synthesis was performed to assess the impact on biodiversity and on ecosystem services of (1) the conversion of natural forest into cacao and coffee agroforestry and (2) the further intensification of agroforest into cacao and coffee plantation.

Search strategy and selection criteria

Data were collected from the literature found in the ISI Web of Knowledge. A search was performed in February 2012, without restriction on publication year. A list of research articles was generated using combinations of the keywords (cacao* or cocoa* or coffe*) and (diversity or biodivers* or ecosystem* or service*). Publications were selected from the retrieved list if they compared species numbers and/or ecosystem services between different land use categories, and also reported the variance or standard deviation of the measurements.

Data and analysis

All calculated effect sizes were used as dependent variables in mixed linear models. First, to estimate whether the mean effect sizes were significantly different from zero (indicating management intensification effects), an intercept-only model was run. Second, to evaluate whether effect sizes were different between crops, continents, taxonomic groups and ecosystem service categories, mixed models were ran with these variables and their interactions as independent variables. Study was always included in the models as a random factor to account for pseudoreplication. The effect sizes were always standardized by the variance of the variable measured, giving greater weight to studies with low variance measures. Therefore, a weight factor (1/variance) was included for each record.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
74	Cocoa and coffee agroforestry in tropics.	Plantation with sparse shade trees (plantation) and Agroforestry with a stratified and diverse tree layer (agroforestry)	Natural forest	Hedge g (standardized difference) comparing species richness and logarithm of ratio for comparing ecosystem services between intervention and control.	81%

Results

- Forest species richness and total species richness were significantly lower in the more intensively managed than in the more natural land use categories.
- Response ratios showed that the decline in total species richness was higher when comparing agroforest with plantation (–46%), than when comparing forest with agroforest (–11%).
- No significant main effect of crop type (coffee vs. cacao) on species richness following management intensification. Pairwise comparisons between continents showed that species richness decline with intensification was significantly higher in Latin America than in Asia ($p = 0.018$), with Africa at an intermediate position
- When comparing overall species richness between agroforest and forest, there was a significant effect of taxonomic group in Asia, but not in Latin America ($p = 0.002$ and $p = 0.438$, respectively). For this analysis, insufficient data were available for Africa ($n = 7$).
- Knowledge gaps related to a conspicuous lack of studies in Africa, and a general underreporting of ecosystem services and environmental variables related to agricultural intensification. No comparison with plantation without shade trees.

Factors influencing effect sizes

Regions and species groups.

Conclusion

Our results show negative effects of (1) the conversion of natural forest into coffee and cacao agroforestry systems and (2) the intensification of cacao and coffee agroforestry into plantation.