Agroforestry and biodiversity

Reference 7

Background and objective

Tropical agroforestry systems have been proposed as a biodiversity friendly way of agriculture, sustaining both biodiversity, the associated ecosystem services and food production. Intensification practices include the recurrent removal of weeds and shrubs, the removal of (slow growing) tree species that are sub-optimal for the provision of shade, and the thinning of shade trees. The ultimate consequence is the transformation of the natural forest into a plantation with an open and species poor canopy, or no canopy at all. (i)Is there a decline of biodiversity and ecosystem services with increasing management across a forest-agroforest-plantation gradient? (ii) are trends consistent across different continents, taxonomic groups and categories of ecosystem services? and (iii) are trends consistent in coffee and cacao cultivation systems? Here, we report only results regarding biodiversity.

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. We examined publications for measures of species richness in general and, where available, of typical forest species in particular.

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), we ran intercept-only models. Second, to evaluate whether effect sizes were different between crops, continents, taxonomic groups and ecosystem service categories, we ran mixed models 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
59	Coffee and cacao production in tropics.	Multistrata agroforestry (stratified and species-diverse tree layer).	1)natural forest (hereafter forest), 2) plantations with sparse shade trees, belonging to one or very few species (hereafter plantation). Plantations without shade trees ("sun plantations") were not included.	1)Hedges' g (standardized difference) comparing total (trees, epiphytes, herbaceous plants, birds, mammals, other vertebrates, ants and other arthropods) and forest (trees, epiphytes and forest animals) species richness between native forests and agroforests. 2) Hedges' g (standardized difference) comparing total and forest species richness between agroforests and plantations.	75%

Results

- When forest is conversed to agroforest only the number of forest species declined. Response ratios indicated a significant 11% decrease in total species richness with management intensification from forest to agroforest. For forest species, the differences were larger, with a decline of 35% (forest–agroforest).

- Intensification from agroforest to plantation resulted in a significant decline of both forest and non-forest species (46% decrease). For forest species, the differences were larger, with a decline of 65% (agroforest–plantation).

- The full linear mixed models revealed no significant main effect of crop type (coffee vs. cacao) on species richness following management intensification.

- There was a significant effect of continent on Hedges' g when comparing overall species richness between agroforest and plantation. Species richness decline with intensification was significantly higher in Latin America than in Asia, with Africa at an intermediate position.

- In coffee systems, no significantly different response in total species richness between taxa was found, whereas in cacao systems there were significant differences between taxa, with trees being the most sensitive group.

Factors influencing effect sizes

NA

Conclusion

Results show negative effects of (i) the conversion of natural forest into coffee and cacao agroforestry systems and (ii) the intensification of cacao and coffee agroforestry into plantation, on species richness. Along with the conservation of natural forest, there is a clear advantage of conserving structurally complex (multistrata) agroforests from further intensification.