Agroforestry and biodiversity

Reference 4

Norgrove, L; Beck, J. 2016 Biodiversity Function and Resilience in Tropical Agroforestry Systems Including Shifting Cultivation Current Forestry Reports volume 2, 62–80. doi: 10.1007/s40725-016-0032-1

Background and objective

Agroforestry preserves, most probably, much more of the (usually forest-bound) biodiversity than would the conversion of forests to non-forest agricultural systems. At the same time, there may be an economic benefit in maintaining high biodiversity, hence many beneficial ecological functions, in an agricultural system. This hope is sustained by experimental evidence from temperate-region grassland systems that showed a beneficial effect of biodiversity on biomass production Deciding how effective the agroforestry system is in conserving biodiversity compared with a forestry agricultural landscape mosaic, and what is known about the relationship with productivity; evaluating the evidence base for the beneficial role of biodiversity on yield and farm-level economy: assess the resilience of biodiversity in agroforestry systems. Here, only results regarding biodiversity are reported.

Search strategy and selection criteria

Literature search conducted in SCOPUS on 1 June 2015, by searching for the following combinations of words in the title, abstract, or keywords: (agroforestry OR swidden OR “hedgerow intercropping” OR “alley cropping” OR agrosilviculture OR home garden OR “shifting cultivation” OR “planted fallows” OR “improved fallows” OR taungya OR agrisilviculture OR “slash and burn”) AND (biodiversity OR “ecosystem function” OR diversity OR “species richness” OR “Shannon-Wiener index” OR “Simpson index”) AND (tropic*). We limited our search to journal articles within environmental and agricultural sciences. There was no time limitation. Papers that examined changes over time within a particular system and those from shifting cultivation studies that assessed the residual management effects of the previous cropping phase. Manually excluded articles: review articles, those from outside the geographical tropics, those that did not contain biodiversity data, and two articles that we were unable to access. To limit the enormous potential scope, we also excluded articles where animals were a major component of the system, such as sylvopastoralism.

Data and analysis

No quantitative estimation is reported.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
146 articles	Tropical agricultural systems.	Shifting cultivation (or “slash-and-burn,” swidden), homegardens, improved fallows, alley cropping, agrisilviculture, shade commodities.	More studies contained forest controls (63 %) than agricultural controls (20 %), and only 19 % contained both types of controls.	Proportion of studies reporting the effect of agroforestry on: 1) Planned cultivated biodiversity, consisting of the crop mix planted by the farmer; 2) Spontaneous volunteer biodiversity, i.e., marketable or useful species that were not planted, but are tended by the farmer; 3) Within-system functional biodiversity, e.g., regulators of soil fertility, natural enemies of crop pests, decomposer microbes, nitrogen fixers, pollinators of food crops, and trees present within the agroforestry system; 4) Out-of-system functional biodiversity, which has a landscape-wide benefit in adjacent cropping systems, such as pollinators of crops or predators of crop pests not in the agroforestry system but in other production systems in the landscape; 5) Heritage biodiversity, i.e., biodiversity not known to be directly linked to the functioning of the agroforestry system or production systems in the landscape, but of conservation value.	31%

Results

- Many agroforests (approximately 2/3) had significantly lower tested diversity than forest.
- Less than half (41 %) had significantly higher diversity than the agricultural control.
- No study found a negative correlation between shade level and biodiversity, there were eight occurrences of significantly positive effects, and 17 results were non-significant. Shade levels and tree diversity were, generally, positively correlated. Shade effects were always positive on the diversity of birds; non-significant on amphibians, reptiles, and (mostly) invertebrates; and mixed on non-woody plants.
- Of papers including at least three age categories and a primary or old growth forest, 9 studies had significant positive linear regressions between species richness and age for any particular group, while the rest were non-significant (14)
- It took at least 48 years for species richness to approach 80 % of the value of the primary forest, and this estimate did not vary consistently between taxa or ecoregion

Factors influencing effect sizes

No study found a negative correlation between shade level and biodiversity, there were eight occurrences of significantly positive effects, and 17 results were non-significant. Eight papers looked at factors other than fallow age affecting biodiversity resilience in shifting cultivation. Factors comprised a mix of residual management effects and landscape configuration.

Conclusion

Comparisons of biodiversity to those of control habitats suggest that agroforestry has more conservation potential than agriculture but that it cannot substitute oldgrowth forests. Management practices (mostly shading regime in commodity crops) were studied either in relation to farmer’s benefits or to biodiversity, but rarely both. While shade was often associated with higher biodiversity, most studies fell short of fully evaluating economic effects for farmers. Resilience, in the sense of biodiversity recovery to old-growth levels, was studied mostly in shifting cultivation systems (i.e., using fallow age as predictor).