Agroforestry and pests and diseases

Reference 3

Pumarino, L; Sileshi, GW; Gripenberg, S; Kaartinen, R; Barrios, E; Muchane, MN; Midega, C; Jonsson, M. 2015 Effects of agroforestry on pest, disease and weed control: a meta-analysis. Basic and applied ecology 16:573-582. doi: 10.1016/j.baae.2015.08.006

Background and objective

Evidence is mounting that agroforestry influences other ecosystem services delivered by biodiversity, such as pest control. However, quantitative reviews of the effects of agroforestry on pest control are still lacking. The objective of this meta-analysis was to investigate the effects of agroforestry practices on the abundance of invertebrate pests, weeds, diseases, natural enemies, and crop damage. This study also assesses whether (1) agroforestry practices affects pests differently in annual vs. perennial crops, (2) whether above and below-ground organisms were differently affected by agroforestry, and (3) if agroforestry practices reduce both parasitic and non-parasitic weeds.

Search strategy and selection criteria

Literature search was conducted using ISI Web of Science, focusing on literature published up to October 2013 reporting the effects of agroforestry on invertebrate pests (insects, mitesand nematodes), plant diseases (fungi, bacteria and virus) and/or weeds. We considered both sequential and simultaneous agroforestry systems. Sequential systems include improved fallows, relay cropping with trees and rotational woodlot systems where a piece of land is deliberately planted with fast-growing nitrogen-fixing trees. Simultaneous systems include scattered trees in crop land, often known as parkland agroforestry, alley cropping, cereal-tree inter-cropping and multi-strata agroforestry. The literature search was conducted using 20 terms describing agroforestry interventions and 10 terms describing response variables. Papers that presented data on any of the following variables were considered: (1) pest abundance, (2) proportion of plant damage due to pests and diseases, (3) abundance of natural enemies, (4) diversity of natural enemies, (5) proportion of pests predated or parasitized and (6) weed abundance. A study had to fulfil the following criteria: (1) the study was conducted at the plot, field or farm scale, (2) a measure of pest control was reported for both a control treatment (i.e. the crop grown without the agro-forestry intervention or under low levels of shade) and for one or more treatments subjected to either agroforestry interventions, or higher shade levels, and (3) the same crop was grown in both treatment and control.

Data and analysis

The mean values of pest abundance, plant damage, natural enemy abundance, and weed abundance for the treatment and control groups were recorded from all studies. RR is defined as the ratio of the treatment mean to the corresponding control mean for each study. log(RR) was analyzed using a mixed-effect model without weighting. The effect of moderator variables (i.e. annual vs. perennial crops, above vs.belowground organisms, parasitic vs. non-parasitic weeds) were tested using a mixed modelling approach, allowing for random variation in effect sizes within groups (i.e. between studies within groups) and fixed differences between groups. Publication bias was analyzed.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
42	Agrosforestry systems (sequential or simultaneous) applied to cropland.	Same crop grown in agroforestry or higher shade levels. Symultaneous agroforestry: scattered trees in crop land, often known as “parkland agroforestry”, alley cropping, cereal-tree intercropping and multi-strata agroforestry. Sequential agroforestry: improved fallows, relay cropping with trees and rotational woodlot systems where a piece of land is deliberately planted with fast-growing nitrogen-fixing trees.	Crop grown without the agroforestry intervention or under low levels of shade.	Ratio of damage or pest abundance in agroforestry practices to damage or pest abundance in cropland or low-shaded cropland.	75%

Results

- Weeds were significantly less abundant under agroforestry compared to control cropland. Agroforestry significantly reduced non-parasitic weeds and had a marginally significant positive effect on control of parasitic weeds.
- Natural enemies of pests were significantly more abundant under agroforestry. Overall, plant damage due to pests and plant diseases was significantly reduced by agroforestry, but pest abundance was not significantly affected. However, the significant reduction of both pest abundance and plant damage was observed for perennial crops, whereas agroforestry had no effect in annual crops.
- There was no difference between above and belowground pest abundance and plant damage.
- The majority of studies (7 out of 11) showed no effect of agroforestry on enemy diversity and the response of predation and parasitism was mixed, with 3 of the 7 studies showing no effect and the remainder split evenly between positive and negative effects.
- Potential publication bias for plant damage due to pest and disease.

Factors influencing effect sizes

Types of pest: stronger effect on weeds. Crop type: effects stronger for perennial than annual crops. The diversity of natural enemies was in most studies not affected by agroforestry. A reason for this might be that the agroforestry treatments usually had low richness of trees, and that the agroforestry trees sometimes were exotic to the study region

Conclusion

This meta-analysis indicates that agroforestry generally benefits most aspects of natural pest control.