Agroforestry and erosion

Reference 2

Kuyah, S; Whitney, CW; Jonsson, M; Sileshi, GW; Oborn, I; Muthuri, CW; Luedeling, E. 2019 Agroforestry delivers a win-win solution for ecosystem services in sub-Saharan Africa. A meta-analysis. Agronomy for Sustainable Development 39, 47. doi: 10.1007/s13593-019-0589-8

Background and objective

Hypothesis is that agroforestry reduces trade-offs between provisioning (crop yield) and regulating/maintenance ecosystem services (including soil nutrients, soil erosion control, soil organic carbon). This meta-analysis addresses the following questions: 1) What is the impact of agroforestry on crop yield, soil fertility, erosion control, and water regulation?; 2) Under which ecological conditions (agro-ecological zone, elevation, and soil type) does agroforestry have a positive or a negative effect?; 3) What is the impact of management (site of trial and agroforestry practice) on agroforestry's effect on crop yield, soil fertility, erosion control, and water regulation?; 4) How do different shrub and tree species differ regarding their potential to regulate these ecosystem services? Here, only results regaring soil erosion are reported.

Search strategy and selection criteria

A literature search was conducted in Web of Science covering all years from 1945 until June 2018. Other sources include a recent structured vote count review, a meta-analysis and a narrative review. All studies and bibliographies were screened for other relevant publications. Criteria: 1) Paper published in a peer-reviewed scientific journal; unpublished literature and grey literature were excluded. 2) Study conducted on a research station or farmer's field in SSA. 3) Study investigated the effect of trees on ecosystem services with a suitable control, i.e., a tree-based system compared with tree-less, or investigation beneath tree crowns compared with investigation outside tree crowns. 4) Original field observation or experimental studies, excluding laboratory studies, greenhouse experiments, modeling studies, anecdotal observations, and reviews. 5) Studies reporting quantitative information on the sample size and the mean value of the response variable.

Data and analysis

Response Ratios (RR) were calculated for all pairs (agroforestry and non-agroforestry) of independent data points, hereafter referred to as observations. Bootstrapping methods were used to estimate 95% confidence intervals around weighted means of RR for different categorical variables through the application of 10,000 iterations using the boot package in the R programming language 3.4.2. Analyses of trade-offs were performed on studies that recorded both yield and soil fertility or water regulation. The percentage of observations belonging to win-win, trade-offs, and lose-lose situations was calculated and the data were plotted in a Cartesian plane to facilitate visualization. Spearman's rank correlation tests were performed between effect sizes of different ecosystem service indicators to determine whether they co-varied positively.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
73	Agricultural systems in sub-saharian Africa.	Agroforestry practices: alley cropping, dispersed intercropping, hedgerow, planted fallow, and crops planted under tree canopies in parkland agroforestry systems.	Non-agroforestry practices (includes sole cropping, continuous cropping without trees, and plots outside tree crowns in the case of parklands).	Ratio of soil erosion parameters (runoff, soil loss) in agroforestry to soil erosion parameters (runoff, soil loss) in non-agroforestry practices.	81%

Results

- Agroforestry performed best in terms of erosion reduction: five and ten times better than cropland plots for runoff (RR: 5.0; 95% CI: 3.3-7.9) and soil loss (RR: 9.7; 95% CI: 5.9-17.3).
- Erosion control with agroforestry was more effective in both humid (RR 7.2; 95% CI 4.8 to 13.9) and semi-arid zones (RR 8.0; 95% CI 4.8 to 16.7) compared to cropland.
- Erosion control with agroforestry was more effective when either shrubs (RR 6.9; 95% CI 4.6 to 11.4) or trees (RR 11.1; 95% CI 6.1 to 24.7) were planted.
- There were no significant differences in the effects between humid and semi-arid sites, or between trees and shrubs.
- NA

Factors influencing effect sizes

NA

Conclusion

Agroforestry practices significantly reduce soil erosion rates, compared to non-agroforestry cropping. This happened for all types of agroforestry, type of soil, ecological zone, elevation, type of perennials used.