# Agroforestry and erosion

## Reference 1

Muchane, MN; Sileshi GW; Gripenberg, S; Jonsson, M; Pumariño, L; Barrios, E. 2020 Agroforestry boosts soil health in the humid and sub-humid tropics: A meta-analysis. Agriculture, Ecosystems & Environment, 295, 106899. doi: 10.1016/j.agee.2020.106899

## Background and objective

Although several studies assessing the effects of agroforestry on various soil properties have been published in the last three decades, a quantitative synthesis of the results from those studies is still lacking. Quantify the contribution of agroforestry practices to soil-mediated ecosystem services, specifically: 1) regulation of soil erosion, 2) storage of soil carbon (C), 3) storage of soil nitrogen (N), 4) availability of soil N, 5) availability of soil phosphorus (P), and 6) alleviation of soil acidity. Here, only results regarding objective 1 (regulation of soil erosion) are reported.

## Search strategy and selection criteria

Literature search was focussed on well-designed and randomized studies that compared plots where crops were associated with trees (agroforestry) with adjacent plots where crops were grown without trees (crop monocultures). Publications for the meta-analysis were first identified using the ISI Web of Science focusing on literature published up to July 2017. They searched published studies that reported the effects of agroforestry on soil health covering the aggregate ecosystem functions of soil structure maintenance and nutrient cycling. 1)The study originated in the humid or sub-humid tropics; 2) The study compared plots representing one or more simultaneous or sequential agroforestry practices with plots of crop monocultures. Studies in which the agroforestry practice involved organic inputs coming from outside (e.g. biomass transfer systems) or in which the tree effect could be confounded with other inputs (e.g. manure inputs as in silvopastoral systems) were excluded from the analysis. Furthermore, rotational woodlots (trees grown>3 years) and home-gardens, often classified as agroforestry practices, were excluded from the current analysis due to lack of studies reporting a proper control plot; 3) The study had the same crop species grown in the agroforestry plotand the corresponding control plot; 4) The study quantified one or several of the indicators of aggregate ecosystem function and soil health; 5) Only studies conducted on research stations and at the farm scale were included, but those at landscape scale and in the laboratory were excluded.

## Data and analysis

Data were extracted from the results section, tables, appendices, graphs and figures from each of the papers. Data from graphs were extracted using IMAGE J software. Whenever multiple agroforestry treatments with different tree species were presented in a given paper, each treatment by control comparison was considered as a separate data point in the meta-analysis. The study also considered treatments based of different tree species compared with the same control as unique observations. If a paper reported results from more than one soil depth, only the upper soil layer (till layer) was considered. In cases where tests were repeated over the growth period, the authors selected the soil measurements made before the last growing season of the experiment to capture the cumulative effects.

| Number of papers | Population | Intervention | Comparator | Outcome | Quality score |
|---|---|---|---|---|---|
| 48 (total N), 34 (soil inorganic N), 49 (soil inorganic P), 46 (soil pH) | Crop production systems in tropics. | 1)simultaneous agroforestry where trees and crops occur on the same piece of land during the same cropping season (e.g. alley cropping, intercropping, multi-storey agroforests); and 2) sequential agroforestry where trees and crops occur on the same piece of land but in a temporal sequence as part of a rotation (e.g. improved fallows). | Crop monocolture. | Logarithm of ratio of soil erosion rates (erosion, runoff, porosity) in agroforestry practices to soil erosion rates (erosion, runoff, porosity, infiltration) in crop monoculture. | 75% |

## Results

- In all studies, RR was less than 1 indicating that soil erosion rates were significantly lower under agroforestry compared to the corresponding crop monocultures.
- Overall, agroforestry trees reduced soil erosion by 50 %, compared to crop monoculture.
- Soil macroaggregates (> 0.25 mm) and mean weight diameter (MWD) were significantly higher under agroforestry than in the crop monocultures; the increases being 22 and 30 % for macroaggregates and MWD, respectively.
- Runoff was 57 % lower under agroforestry than crop monoculture.
- NA

## Factors influencing effect sizes

Tree species that do not fix N generally contributed to lower erosion (RR = 0.29) than N-fixing trees (RR = 0.41). The effect sizes for erosion rates also did not significantly differ among soil texture classes, but loamy soils had generally lower erosion rates than sandy soils.

## Conclusion

Agroforestry practices significantly reduce soil erosion rates, compared to crop monocultures. The provision of organic inputs by agroforestry trees through litterfall and prunings contributes to soil cover. Trees can also provide physical barriers to soil erosion. This combined with the predominance of reduced/no-tillage practices in agroforestry is likely an important reason for the lower soil erosion rates.