

Background and Justification

Agroforestry (e.g. Fig. 1) provides food and other products, while improving soil fertility, erosion control, water regulation and other regulating / maintenance ecosystem services. The supply of these services varies from place to place, and may include trade-offs.

There are no comprehensive evaluations of the overall effect of agroforestry on ecosystem service provision in sub-Saharan Africa (SSA). It is also difficult to tell the degree to which different ecological conditions and management influence this potential.

We used a meta-analysis to quantify effects of agroforestry on crop yield, soil fertility, erosion control and water regulation in SSA. The analysis focused on studies comparing agroforestry and non-agroforestry systems.



Fig. 1. Collard intercropped with *Grevillea robusta* in Western Kenya. Agroforestry can improve crop yield by regulating microclimate and improving soil fertility.

Research objectives

1. To determine the overall effect of agroforestry on crop yield, soil fertility, erosion control and water regulation.
2. To determine the effect of different ecological conditions, management and woody perennials on provision of these ecosystem services.

Literature search

A literature search on ISI Web of Science and ProQuest covering 1945 to May 2018 yielded 126 refereed papers with 1106 datapoints from studies conducted in 21 countries.

Further reading

1. Kuyah et al. 2016. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 13(1):255-273
2. Luedeling E, Shepherd K, 2016. Solutions 7:46-54
3. Luedeling E, Smethurst PJ, Baudron F, et al. 2016. Agric. Syst. 142:51-69



Results

Overall effects of agroforestry

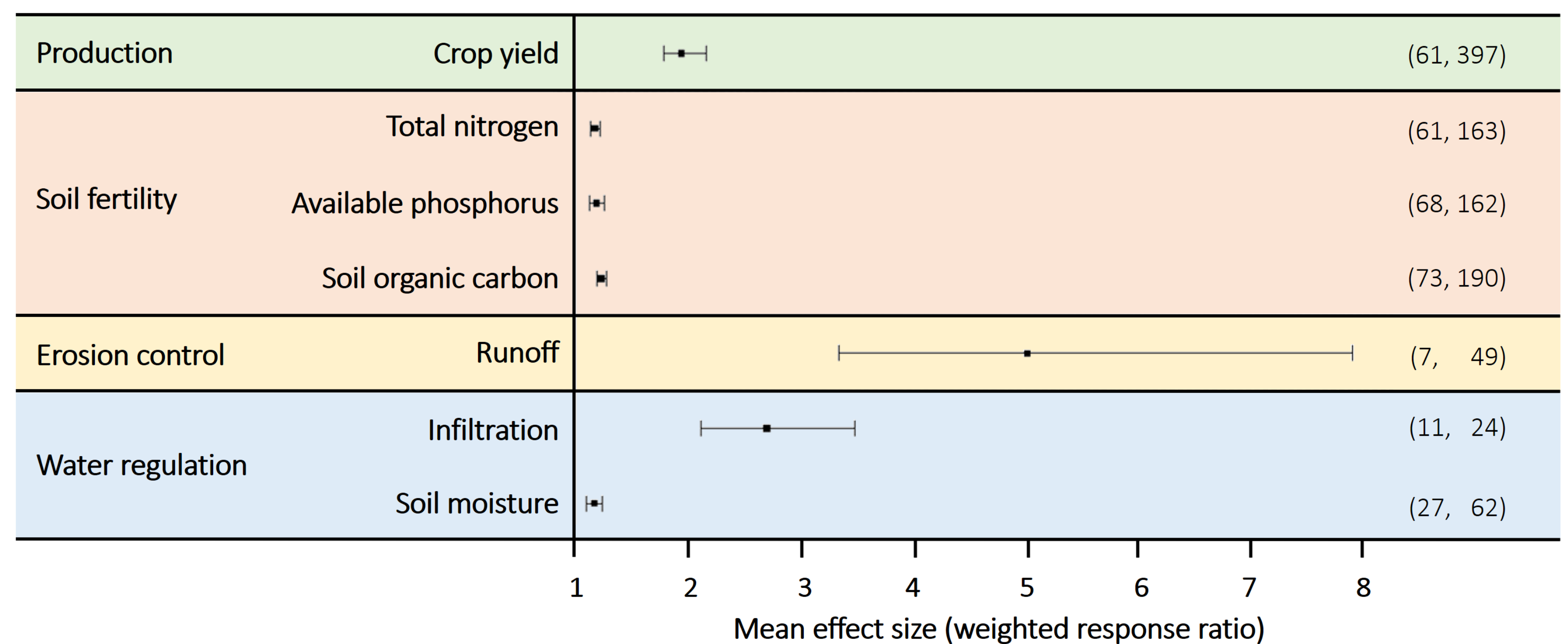


Fig. 2. Effect of agroforestry on crop yield, and indicators of soil fertility and water regulation. Response ratio (RR) is the ratio of the value of an ecosystem service in agroforestry to that in non-agroforestry. Parentheses: (# papers, # observations).

- Agroforestry significantly improved provision of all ecosystem services compared to control (Fig. 2).
- Average crop yield was almost twice higher in agroforestry (RR = 1.9) compared to control.
- Control of runoff and soil loss was five (RR=5.0) and ten (RR=9.7) times better in agroforestry.
- Infiltration was about three times (RR=2.7) higher in agroforestry.

Effect of ecological and management conditions

Fig. 3. Alley cropping with *Gliciridia sepium* and common bean in Eastern Rwanda. Agroforestry can facilitate crops by nitrogen fixation, mulch production and erosion control.



- No significant differences were detected between the different ecological conditions, management and types of woody perennials for any of the ecosystem services (e.g. Fig. 1 and Fig. 2).
- The main tradeoffs included low available phosphorus against higher values of crop yield, total nitrogen and soil organic carbon, and low soil moisture content against higher crop yield.

Outlook

- Holistic valuation of ecosystem services in agroforestry
 - Develop a generic prediction model for ecosystem services
 - Estimate overall ecosystem service value of agroforestry