SINGLE FICHE – AGROFORESTRY

IMPACT: INCREASE SOIL NUTRIENTS

Data extracted in June 2020

This fiche summarises the impact of Agroforestry on SOIL NUTRIENTS. It is based on a review of 7 peer-reviewed synthesis research papers, each involving 21 to 138 individual papers.

This fiche is part of a set of similar fiches synthesising all the impacts of agroforestry presented in the general fiche

1. WEIGHT OF THE EVIDENCE

- CONSISTENCY OF THE IMPACT: Out of the 7 synthesis papers dealing with this type of impact, 5 show positive effect of agroforestry on soil nutrients: 4 comparing agroforestry to land use without trees (cropland and pastureland) at the global scale (mainly in Arid and Tropical zones), and one comparing it to forests in Europe. Three synthesis papers report an uncertain effect: two in West Africa (one compared to cropland and one unspecified) and one in Europe (compared to cropland and pastureland). See the table below for details.

Impact	Comparator	Effects (all studies)				Effects (only studies including EU)			
		Positive	Negative	No effect	Uncertain	Positive	Negative	No effect	Uncertain
Increase soil nutrients	Land use without trees	4 (3)	0	0	2 (1)	0	0	0	0
	Forests	1	0	0	0	1	0	0	0

- QUALITY OF THE SYNTHESIS PAPERS: [The quality score summarises 16 criteria assessing the quality of three main aspects of the synthesis papers: 1) the literature search strategy and studies selection; 2) the statistical analysis; 3) the potential bias. The scores can be found in the Excel database with all the data extracted from the synthesis papers]

  As shown in the "Quality score" of the table in section 2, the quality level ranges from 44% to 81%, with only one synthesis paper with a quality score lower than 50%. The least frequently satisfied quality criteria were those related to the dataset availability (1 out of 7), presentation of individual effect sizes (2 out of 7), weighting of individual studies (2 out of 7), analysis of heterogeneity of the effects (satisfied in 2 synthesis papers out of 7) and analysis of publication bias (2 out of 7).

- NUMBER OF SCIENTIFIC PAPERS: The number of papers included in each synthesis paper ranges from 21 to 138.

2. IMPACTS

The main characteristics and results of the 7 synthesis papers are summarized in the table presented below. For details follow this link

	Reference	Population	Geographical scale	Intervention	Comparator	Conclusion	Quality score	Global effect
1	Muchane, MN; Sileshi GW; Gripenberg, S; Jonsson, M; Pumariño, L; Barrios, E. 2020	Crop production systems in tropical climates.	Humid and sub-humid tropics in all continents.	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 monoculture.	Agroforestry practices significantly increase N storage, increase the availability of inorganic N and marginally increase the availability of inorganic P and pH in the soil compared to crop monocultures. As such, agroforestry can be an option for increasing soil nutrient availability to crops when access or use of mineral fertilizers is limited. Furthermore, by facilitating the combined application of organic and mineral nutrient inputs to soil, agroforestry can significantly improve nutrient use efficiency through greater synchronization of nutrient release to soil and crop demand and use.	75%	Positive, compared to crop monoculture.
2	Kuyah, S; Whitney, CW; Jonsson, M; Sileshi, GW; Oborn, I; Muthuri, CW; Luedeling, E. 2019	Agricultural systems in sub-saharian Africa.	Sub-Saharan 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).	The analysis has demonstrated that soil was more fertile in agroforestry than in non-agroforestry practices. It was infered that trees were the main source of nitrogen, since crop residues are usually removed with the harvest.	81%	Positive, compared to non-agroforestry practices on cropland.
3	Bayala, J; Kalinganire, A; Sileshi, GW; Tondoh, JE. 2018	Arable land in (tropial and semi-arid) sub-Saharan Africa	Sub-Saharan Africa covering an area from humid to semi-arid zones.	Plots with one agroforestry practice among alley cropping, improved fallow, mulching and parkland.	Plots without alley cropping, improved fallow, mulching and parkland.	All agroforestry practices (except improved fallows) significantly increased nitrogen over the control. C:N ratios showed the highest values in mulching and parklands as opposed to the alley	50%	Positive, compared to plots without agroforestry.

					cropping where nitrogen fixing species are incorporated.		
4	Felix, GF; Scholberg, JMS; Clermont-Dauphin, C; Cournac, L; Tittonell, P. 2018	Cropping systems with trees in semi-arid West Africa.	Semi-arid west Africa (Sudano-Sahelian Africa, including Senegal, The Gambia, Mauritania, Mali, Burkina Faso, Northern Benin, Niger, Nigeria, and Northern Cameroon).	Plots under or at the vicinity of tree canopy. Plots receiving ramial wood as soil amendment.	Plot outside the area of canopy influence. Plot not receiving ramial wood as soil amendment.	Presence of trees, shrubs and ramial wood amendments had overall positive effects on nitrogen contents.	50%	Uncertain
5	Torralba, M; Fagerholm, N; Burgess, PJ; Moreno, G; Plieninger, T. 2016	Agricultural land, pasture, forestry land in the EU.	Europe	Agroforestry (silvoarable, silvopasture and mixed).	1)Agricultural land, 2)pasture land, 3) forestry land (natural and planted).	When compared with forestry, agroforestry had a significant positive effect on soil fertility/nutrient cycling. In comparison with pastureland and agricultural land, no significant differences were reported.	81%	Positive compared to forestry (natural and planted). Uncertain, compared to agricultural land and pasture land.
6	Sileshi, GW. 2016	Faidherbia trees on arable land (arid zones).	Global (Arid zones)	Agroforestry: Scattered Faidherbia albida trees in crop systems.	Open area or patches taken furthest from the tree trunk, in the same field as the intervention.	Faidherbia induces significant changes in soil properties and fertility under its canopy. Faidherbia probably does not mine nutrients from the surrounding open area. Its influence on soil properties creates spatial patterns that vary with distance from the trunk in a predictable manner.	44%	Positive, compared to open areas without trees.
7	Sinare, H; Gordon, LJ. 2015	Cropland and pastureland in Sudano-Sahelian zone of West Africa.	Sudano-Sahelian zone of West Africa.	Presence of woody vegetation	Not specified	No clear conclusion available.	50%	Uncertain

3. KNOWLEDGE GAPS

[They are extracted from each meta-analysis, synthesized and consolidated]

- Lack of primary data, especially when focusing on trade-offs between ecosystem services. Six synthesis papers out of 7 did not report data for Europe.

4. SYSTEMATIC REVIEW SEARCH STRATEGY

Keywords	TOPIC: (agroforestry OR "agro-forestry") AND TOPIC: (meta-analy*)
Search dates	No time restrictions
Databases	Web of Science and Scopus, run on 15 May 2020
Selection criteria	Three main criteria led to the exclusion of a study: (1) the study does not deal with agroforestry; (2) the study does not assess the environmental and climate impacts of the farming practice on soil nutrients; (3) the study is neither a meta-analysis nor a systematic review. Studies that passed the relevance criteria were subject to critical appraisal carried out on article by article basis. We finally selected 7 meta-analysis.