Agroforestry and soil nutrient

Reference 6

Background and objective

Faidherbia albida is a leguminous (nitrogen-fixing) tree which presence in the crop fields has been widely reported to increase soil fertility and crop yields. Used to combat desertification and regreening of the Sahel. Faidherbia has also gained prominence in climate -smart agriculture. This review provides analyses of the magnitude and spatial extent of Faidherbia tree impact on soil properties and cereals primary productivity. The meta-analysis aimed to answer the questions: 1) Is there any consistent increase in soil nutrient pools and crop yields due to Faidherbia trees and how large is the effect size?; 2) Does the tree's root system mine a particular nutrient from the soil beyond the reach of its crown?; and 3) Does the tree's root system mine the soil beyond the reach of its crown? Here, onlt data regarding soil nutrients are reported.

Search strategy and selection criteria

Literature search in both published and unpublished sources on secondary data on soil nutrients.

Studies must 1) have been published in a refereed journal, book chapter or peer-reviewed proceeding or any other report; 2) have soil or crop yield measurements 'under canopy' and a corresponding measurement 'outside canopy' to be treated as a well-defined control; 3) have reported the mean as numerical or graphical data; and 4) reported soil properties for each soil depth separately.

Data and analysis

From the studies selected, pairs of observations (under canopy and corresponding values in the open area) on total nitrogen (N), extractable phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and pH were extracted.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
21	Faidherbia trees on arable land (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.	Logarithm of ratio (RR) of soil nutritients measurements (Total N, Extractable P, Extractable K, Extractable Mg, Extractable Ca, pH) under the canopy to soil nutritients measurements in the open area (or patches taken furthest from the tree trunk).	44%

Results

- Significant increases in total nitrogen (50%), phosphorus (21%) and potassium (32%) under canopy vs. open area.

- The decrease in RR (of N, P, K, pH) with an increase in carbon supports the nutrient enrichment scenario rather than nutrient mining.

- Trees growth and canopy development appear to explain the size dependence of the spatial extent of its influence, with a marked influence observed under large trees than small trees.

- Faidherbia influences on soil properties and crops are greatest (RR >> 1) near the tree trunk and gradually decrease towards patches outside the influence zone of the tree approaching RR = 1. The magnitude of tree influence on N, P, K followed a common pattern of distance–decay.

- The influence of the tree extends beyond the drip line. The potential area of crown influence is about 100 - 400 m2.

Factors influencing effect sizes

Soil nutrient richness: larger increases in nutrients occurred on inherently nutrient-poor sites than on nutrient-rich sites. Tree trunk distance: Faidherbia influences on soil properties and crops are greatest (R >> 1) near the tree trunk and gradually decrease towards patches outside the influence zone of the tree. Distance to the tree: the magnitude of tree influence on N, P, K followed a common pattern of distance–decay.

Conclusion

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.