

Plant-soil interactions in multi-strata agroforestry systems with perennial crops

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Introduction

Multi-strata agroforestry systems with perennial crops are wide-spread in the more humid regions of the tropics. They comprise a continuum ranging from small-scale, sometimes highly diversified associations of tree crops which are managed for family consumption and local markets (e.g., homegardens), to export-oriented plantations of the major agricultural crops of the world such as coffee, cocoa and tea if these are grown under shade trees. Research on plant-soil interactions in agroforestry with perennial crops has largely concentrated on the second type of systems, presumably both because of their higher economical interest and their simpler structure. The complex nature of the homegarden-like systems is in fact a major obstacle to the conduction of research on plant-soil interactions, because the spatial heterogeneity of the systems makes it difficult both to obtain and to interpret representative soil data for a system as a whole. However, for the supply of small farmers with little access to the international markets with food and some cash; for the conservation of germplasm diversity of tree crop species of lesser importance; and for the maintenance of a diversity of niches for the fauna and flora in an agricultural landscape, these highly diverse systems may be of considerable importance. They consequently merit research efforts for their understanding and improvement. In this review, we try to organize the available information on plant-soil interactions in multi-strata agroforestry with perennial crops with the objective of developing strategies for the optimization of resource use and the maximization of environmental benefits of such systems.

Two approaches to the analysis of complex agroforestry systems

As in the past research on complex agroforestry systems has suffered from the difficulty of dealing with their complexity, we first discuss two approaches to their analysis.

The first approach is to compare a plot (or a number of plots) under multi-strata agroforestry with control plots under simpler agricultural systems, e.g. the monocultures of one or several of the components of the agroforestry system. The variables to be compared could be the average soil fertility as measured on representative samples from the whole plots, or the water and dissolved nutrient yield from micro-catchments covered with the respective system types. This approach is necessary for the evaluation of the total environmental costs and benefits of a system; however, the information obtained is very specific for the studied systems and gives little information on how its characteristics would be affected if one crop species or management measure was exchanged by another, or how the system could be improved with respect to a certain characteristic.

The second approach is the analysis of the within-plot heterogeneity of a complex agroforestry system in relation to the crop species present and their respective management. The variables

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