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Cocoa agroforestry systems in Central America—biodiversity management for a better trade-off between ecosystem services

In Central America, UMR SYSTEM is working in partnership with the Tropical Agricultural Research and Higher Education Centre (CATIE) and other members of the 'Tree crop-based agroforestry' Research and Training Platform in Partnership (PP) to quantify ecosystem services provided by cocoa-based agroforestry systems*. These systems, which are managed by farmers and their families on small areas (0.25-4 ha), have long been neglected by agricultural research. Since the 1990s, agroforests have been spotlighted for their extraordinarily high wild and cultivated biodiversity and role in supplying many ecosystem services. The multifunctionality of these systems, their structural similarities with tropical forests, the spatial and functional transition between forests and cropping systems that they facilitate, and their various productions makes them a relevant focus of ecological intensification research.

A network of 229 smallholder cocoa agroforest plots was monitored in Central America (Panama, Costa Rica, Nicaragua, Guatemala, Honduras), to:

- measure the productivity of the main crop (cocoa) and the system (supply services)
- gain insight into the relationships between the botanical composition, the spatial structure of the vegetation and the productivity of cocoa trees and the system
- seek trade-offs between the main crop and system performances
- seek levers to adjust the balance between ecosystem supply services (crop productivity), regulation (pollination, pest regulation, carbon sequestration) and support (primary production, wildlife habitat, etc.) provided by these systems.

By integrating forestry and community ecology concepts and tools with those of agronomy to characterize the composition and structure of complex agroforests and quantify the studied ecosystem services, UMR SYSTEM is firmly positioned in the field of the agroecology of agroforestry cropping systems regarding the ecological intensification of their productivity.

Research conducted by UMR SYSTEM and partners is ongoing in this georeferenced plot network under the PP-PCP 'Central America'.

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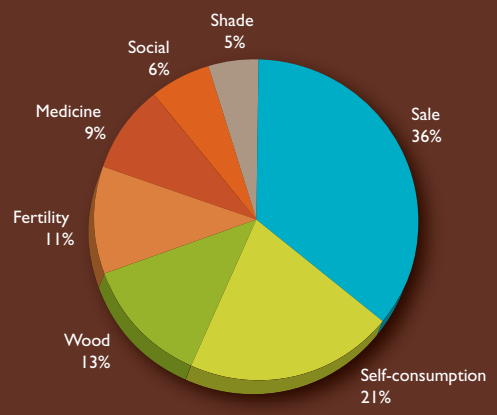
* Studies carried out under the 'Cocoa Central America' project in which UMR SYSTEM coordinated the Research component from 2008 to 2012.

Cocoa farms in central Cameroon—complex systems that meet farmers' needs



▲ *Average use values attributed by Cameroonian farmers to different woody species growing in their cocoa agroforests (study carried out in 2009 on 50 cocoa farms in the central region).*

Within the framework of the 'Agroforestry Cameroon' Research and Training Platform in Partnership, UMR SYSTEM is conducting research on cocoa agroforestry systems in collaboration with the *Institut de recherche agricole pour le développement* (IRAD, Cameroon) and other CIRAD research units (including UPR Performance of Tree Crop-Based Systems). To analyse the performances of these systems—which are hard to assess as a whole—a participatory assessment of 50 cocoa agroforests was carried out based on a use value attributed by farmers for each species in the system. Farmers thus revealed that 80% of the 122 species inventoried in their cocoa stands had between one and seven different uses, thus confirming their multifunctionality. The highest use value was attributed to cocoa trees (24%), but other associated woody species were found to have an explicit value for farmers by meeting the vital needs of farm households, including the sale and consumption of various products (fruits, oil and palm wine), supplies of medicinal products (bark, leaves), timber and fuelwood, preserving soil fertility and generating shade for cocoa trees.

The frequency of these species was also significantly and positively correlated with their use value ($R^2 = 0.914$). This confirms that the multifunctionality of cocoa agroforestry systems is closely associated with their high agrobiodiversity level and that these complex systems are built and managed by farmers over time. Initiatives to improve cocoa cropping systems should thus take this intentional complexity into account so as to meet farmers' needs and ensure better adoption of proposed technical innovations. Designs of new systems should follow the lead of these agroforestry systems so that cocoa production will hereafter be more in line with farmers' strategies while also providing ecosystem services.

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