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## Agroforestry: Lifeline of world cocoa production. Utopia or credible alternative?

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A large part of the world cocoa production is provided by multifunctional agroforestry systems (AFS). Despite their ability to provide a large range of ecosystem services (ES), eg. biodiversity, carbon sequestration, crop production, these systems were however long considered inefficient in terms of cocoa yield and, thus, neglected by agronomists. Our studies are carried out in Cameroon on farmers' cocoa plantations. They are based on 100-year chronosequences and/or a large array of situations, ranging from simple systems to very complex ones. We show that cocoa AFS can reach yields of over 1000 kg ha-1 of marketable cocoa which is in many cases comparable or even better than yields of conventional systems. We found that very long-term sustainability of cocoa AFS could be achieved if the basal area (BA) share of the cacao stand does not exceed 40% of the total BA of the cocoa AFS. Moreover, farmer's management of the different species associated with cocoa trees provides not only continuous cocoa production on the very long-term but also permits interesting combinations of valued products and/or ES. For instance, the combination of expert knowledge and Pareto front algorithms enabled us to shed light on some of the tradeoffs occurring in these systems and to identify clusters of increasing ES provision. Significant differences in associated tree communities and management strategies were identified across these clusters. Furthermore, by combining field observations and historical survey data, we reconstructed the impacts of changes over time on management practices, agroforestry structures and cocoa yields. The long-term trajectories we identified explain the current agroforests structures, with low or high cocoa tree densities, mean basal area per cocoa tree (from 29.4 cm2 to 92.7 cm2), and finally cocoa yields which varied from 542 to 1275kg ha–1. We show that farmer's management of cocoa AFS allows a system balance that can be temporarily broken or redesigned, suggesting the resilient and flexible nature of these complex cocoa agroforests. Despite such results and the increasing recognition of their multifunctionality, cocoa AFS were recently questioned about their putative unsuitability to climate change adaptation. This question appears legitimate and we support that, when necessary, adaptation to climate change in cocoa AFS shall be overcomed by choosing adequate associated species and planting densities. Yet, in order to prevent the possible misuse of this ongoing discussion within the cocoa supply chain, we urge the scientific community to support and keep demonstrating that complex cocoa AFS are valuable, ecofriendly and climate-smart systems. Finally, we argue that these systems should be used to promote the building and establishment of cocoa cropping models that fully include associated flora diversity in order to provide the farmers, the cocoa supply chain and the consumers with sustainable revenue, goods and services.

References:

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