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Revealing yield drivers in Sulawesi cocoa agroforestry: The primacy of farm management over shade levels

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Abstract

Agroforestry has received increasing attention from the cocoa sector as a promising practice to simultaneously address multiple production and sustainability goals. Several studies suggested that at certain shade levels, there are opportunities to significantly increase cocoa yield while improving soil fertility, climate change mitigation and adaptation, as well as supporting farmer's livelihoods. Nevertheless, the effects of shade trees on cocoa have been a central debate for practitioners. Moreover, the definition of cocoa agroforestry (CAFS) is inconsistent across different locations and contexts, since relying on a common indicator such as the number of shade trees could result in differing shade levels depending on species types and crown characteristics. This research aims to characterise CAFS systems on 200 farms across Sulawesi, Indonesia. Combining field-level data from farmer surveys, vegetation assessment, and pod counting for yield estimation, carbon stocks and greenhouse gas emissions are estimated. We identified four CAFS typologies in Sulawesi, which are 1) cocoa-coconut; 2) cocoa-Gliricidia sp.-pepper; 3) mixed CAFS with low carbon value; and 4) mixed CAFS with high carbon value. Cocoa yield did not show significant differences among CAFS typologies, yet considerable variation existed within each typology. A generalised linear model with a Gamma distribution and log-link indicated that cocoa yield was affected by farm management factors rather than shade level or planting density of shade trees. The number of productive trees, combination of clones, and pruning were significant yield drivers. Interestingly, the effects of application of insecticides and inorganic fertilisers were only significant on cocoa yield when pruning was practised. To increase aboveground carbon stocks, different strategies could be tailored per typology; for example, mixed CAFS with low carbon value could enhance carbon sequestration by gradually replacing unproductive mature plants with new ones and introduce additional big shade trees with high wood density along the boundary. Through all typologies, effective use of nitrogen fertilisers would reduce greenhouse gas emissions. Findings from this research provide valuable insights for decision-making and design of effective CAFS in Sulawesi and beyond. It highlights the need for comprehensive baseline data at the farm level and the importance of tailoring recommendations to local contexts.

Keywords: Cocoa agroforestry, cocoa Sulawesi, cocoa yield

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