

## Productivity and income in 5 different cocoa production systems

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### Introduction

Cocoa agroforestry systems, combining cocoa with timber and fruit trees, are mainly promoted for their environmental benefits. Knowledge gaps exist about the economic performance of such systems. Here we present the productivity and income of 5 cocoa production systems from planting to entering the mature stage (11 years).

### Methods

In a long-term trial in Bolivia monocultures and agroforestry systems under both conventional and organic management, and a highly diverse successional agroforestry system (SA) are compared (Schneider et al. 2016). Yields per hectare are based on all harvested products converted to dry matter (0% humidity). Income was calculated using the local farm gate prices of all harvested products converted to USD. For organic cocoa organic premium prices were used.

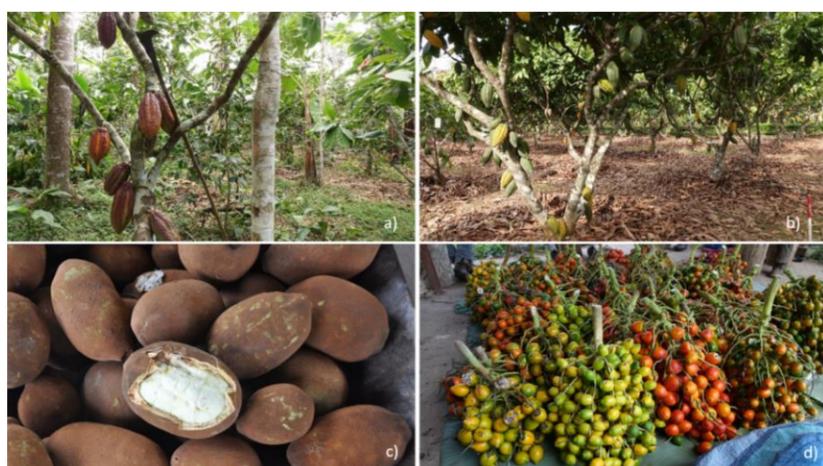


Figure 1: a) Organic agroforestry system (AO) combining cocoa with timber, fruit and legume trees, as well as banana and coffee. b) Conventional monoculture (CM) with chemical fertilizer and herbicide application. c) Fruits of copoazu and d) peach palm, two promising by-crops cultivated in agroforestry systems in Bolivia.

### Results and Discussion

Cocoa yields were lower in the agroforestry systems compared with monocultures, and lowest in SA (Figure 1). For monocultures, they were higher under conventional management, while similar values were recorded in organic and conventional agroforestry systems. Total yield was 3–4 times higher in the agroforestry systems due to banana production (AC,AO) and from a range of diversity of crops (SA).

Income over all years was comparable among all systems (Figure 2). Cocoa was responsible for more than 90 % of the income in monocultures and more than 60% in agroforestry systems, and around 40% in the SA. In agroforestry systems income from by-crops compensated for the lower cocoa yields. Cocoa as the main cash crop, contributed strongly to income, considering harvested volume of by-crops, having high prices and a well developed value chain in the region. The potential of by-crops contribution to family income depends strongly on the development of their markets, e.g. local banana prices were low, while peach palm or pineapple had good prices. In addition, by-crops as well as fruit trees and palms, which are just entering production in the trial, can substantially contribute to families self-consumption.

### Conclusions

With different strategies and plantation designs, similar levels of income could be reached in the first 11 years of production, with a higher systems productivity in agroforestry systems. This indicates, that apart from providing ecosystem services, cocoa agroforestry systems have the potential to sustainably intensify agricultural production, contribute to food security and mitigate risks of price or yield fluctuations in the cash crop.

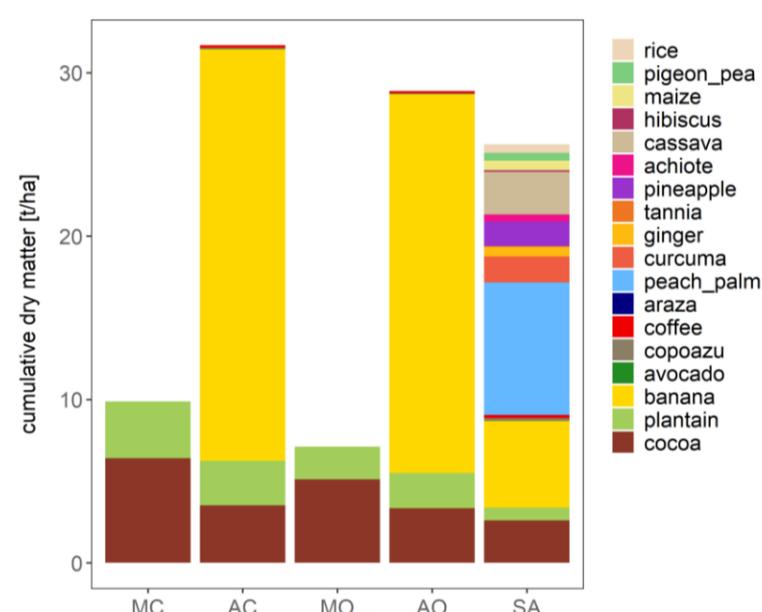


Figure 2: Cumulative dry matter yields over the years 2009-2019 in the 5 production systems (MC = conventional monoculture, AC = conventional agroforestry, MO = organic monoculture, AO = organic agroforestry, SA = successional organic agroforestry).

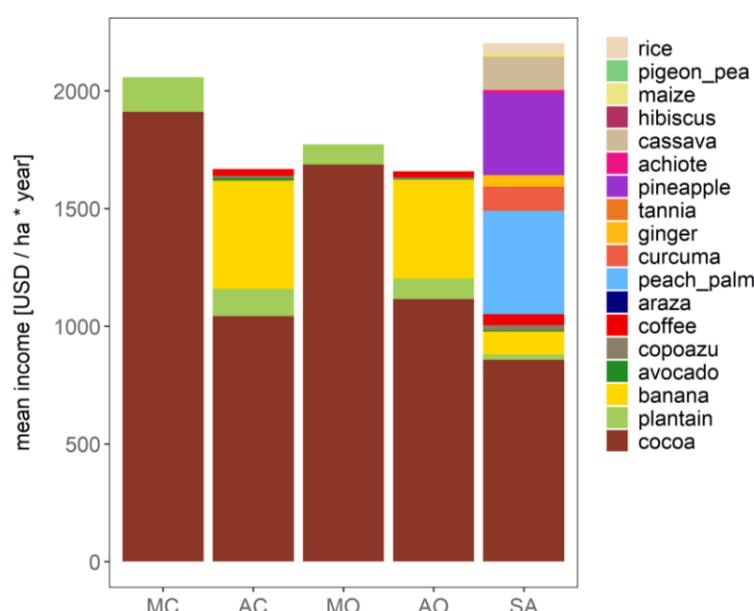


Figure 3: Mean yearly income, based on local farm-gate prices summed up over the years 2009 – 2019 in the 5 production systems.

### References

Schneider, M., Andres, C., Trujillo, G., Alcon, F., Amurrio, E., Perez, E., Weibel, F. and Milz, J. (2016) Cocoa and total system yields of organic and conventional agroforestry vs. monoculture systems in a long-term field trial in Bolivia. *Experimental Agriculture*, 53 (3): 351-374.

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