

Ecosystem service benefits and trade-offs from shade tree communities in cocoa systems

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Methods

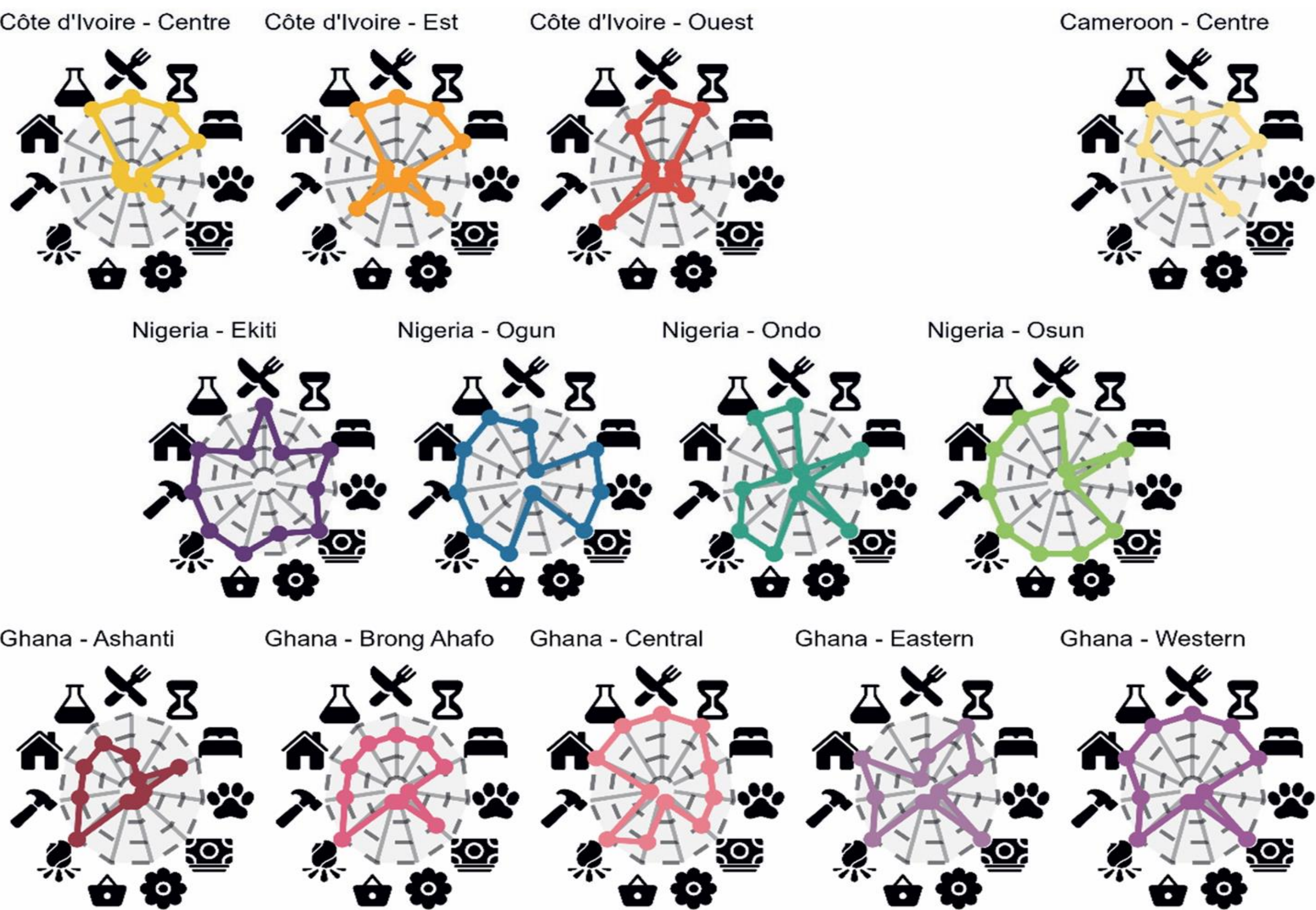
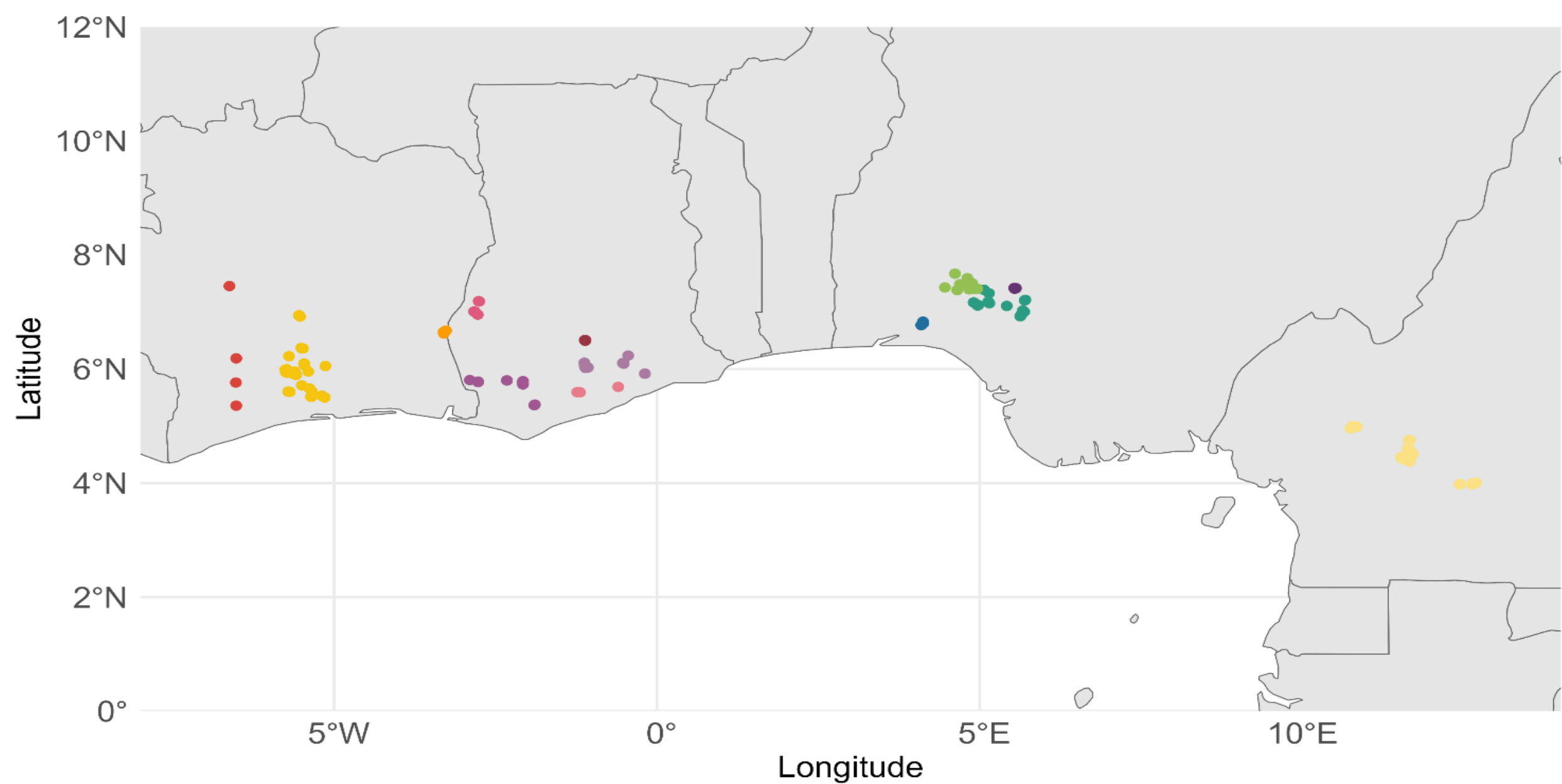
- We assessed the diversity of **shade tree community composition, structure, and functioning** on 168 cocoa farms in Ghana, Côte d'Ivoire, Nigeria and Cameroon.
- We investigated the relationship between shade tree communities and **ecosystem services**, identifying **tree traits and shade trees most preferred by farmers**.
- We used mixed-effects general additive models to examine the relationship between shade tree density, shade tree diversity, and shade tree size on yields.

Key findings

- Shade tree traits can be used to predict their benefits and downsides to farmers; results are corroborated at the farm scale and vary by ecosystem service type.
- When shade tree diversity was low, maximum yields were predicted at low shade tree density, in line with recommendations of 20 trees ha⁻¹.
- When shade tree communities were more diverse, maximum yields could be achieved at tree densities of up to 100 trees ha⁻¹.

Ecosystem service preferences across study regions

- Ecosystem service perceptions differ across subnational regions.
- Perceptions reflect local (historical) land-use and cultural contexts.



Food	Future security	Recreation	Hunting	Marketable goods	Ornaments/tradition	Basketry and cordage	Fuel/firewood	Tools	Construction	Medicine

Figure 1. Location of the farms studied, coloured by region. Spider diagrams show modal responses by region to the ecosystem services questionnaire: the four dashed lines represent each possible answer, "Not Useful", "Less useful", "Useful", and "Very useful", from the inner to outer ring.

Shade tree community characteristics influence ES

Plot-level traits (composition, structure, and function) of on-farm shade tree communities were related to farmer-reported ecosystem services values.

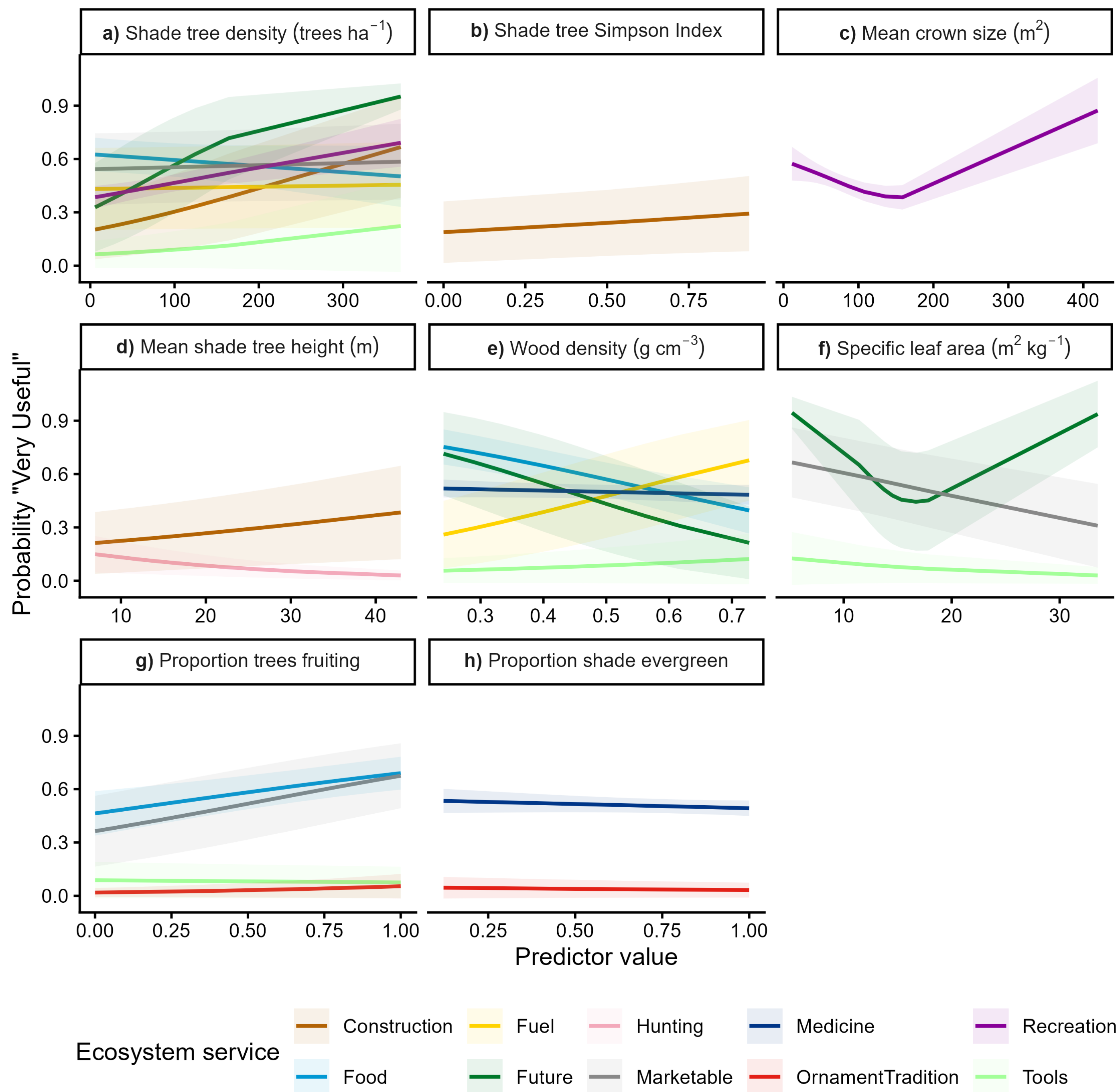


Figure 2. Predicted effects of community-weighted mean traits of shade tree communities on cocoa farms on the probability farmers recognise their farm as "very useful" for certain ecosystem services.

Yield effects of shade tree communities

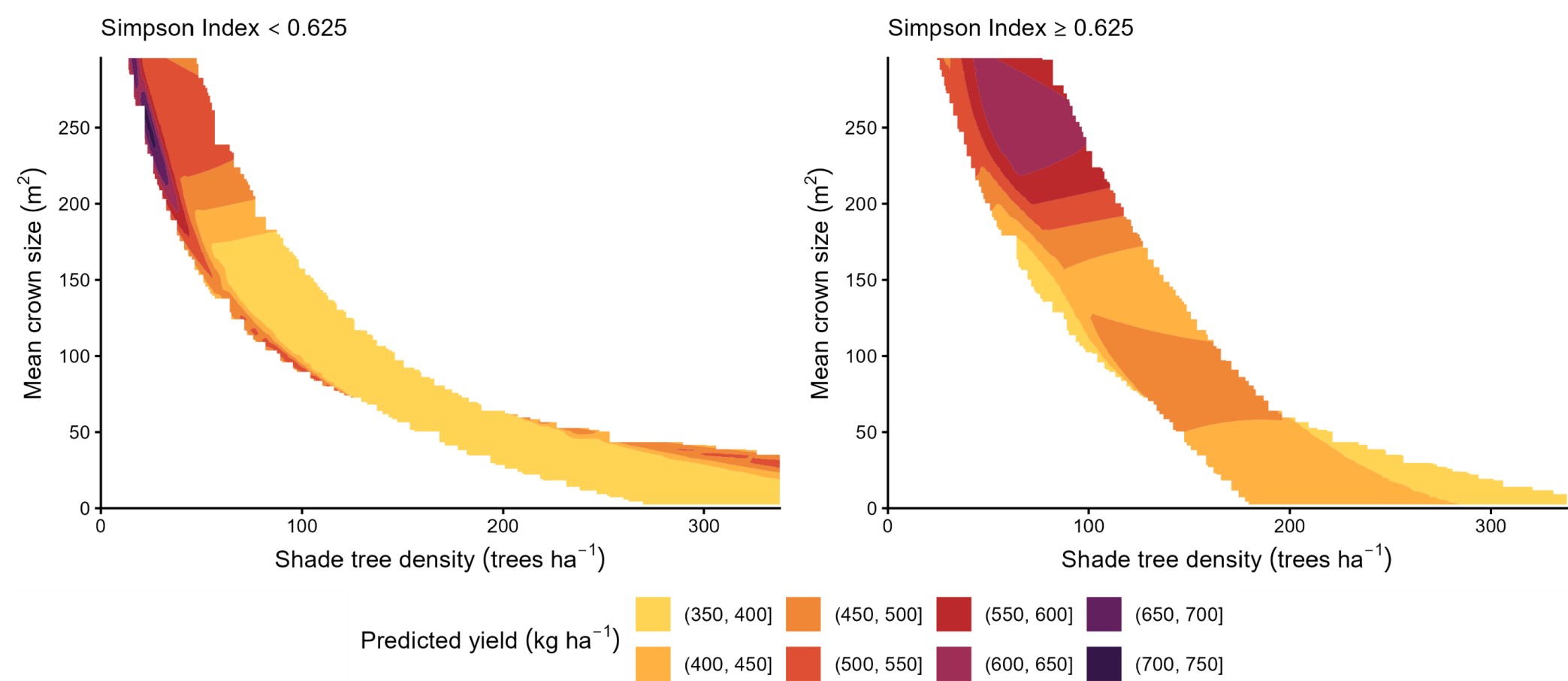


Figure 3. Modelled effects of shade tree composition and structural traits on cocoa yields per hectare at lower and higher shade tree diversity, as predicted within the bounds of achieving 30-40% shade.

Conclusions

- Typical recommendations of 30-40% shade cover, can be achieved in different ways – with different ES and yield outcomes.
- Yield and highly-valued ecosystem service benefits depend on large, mature trees that take a long time to grow.
- Guidance should move beyond shade cover alone and agroforestry programmes should ensure the supply of species that accommodate the role of structure and function in supporting ecosystem services that meet farmer values.

Acknowledgements

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