

Is “regeneration” possible? The drivers of plant diversity in West and Central African cocoa plantations

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IITA
Transforming African Agriculture

Background: biodiversity in cocoa

Cocoa is a major import to the EU - \$9bn/year, and over half the world's supply!

Supply chain focus at environmental impacts at the landscape level but poor understanding of biodiversity at the plot level

Lack of good approaches for addressing biodiversity in cocoa – dearth of widespread biodiversity data *within* cocoa farms

But biodiversity commitments are still being made! No definition yet of “nature positive trade”



Background: biodiversity in cocoa

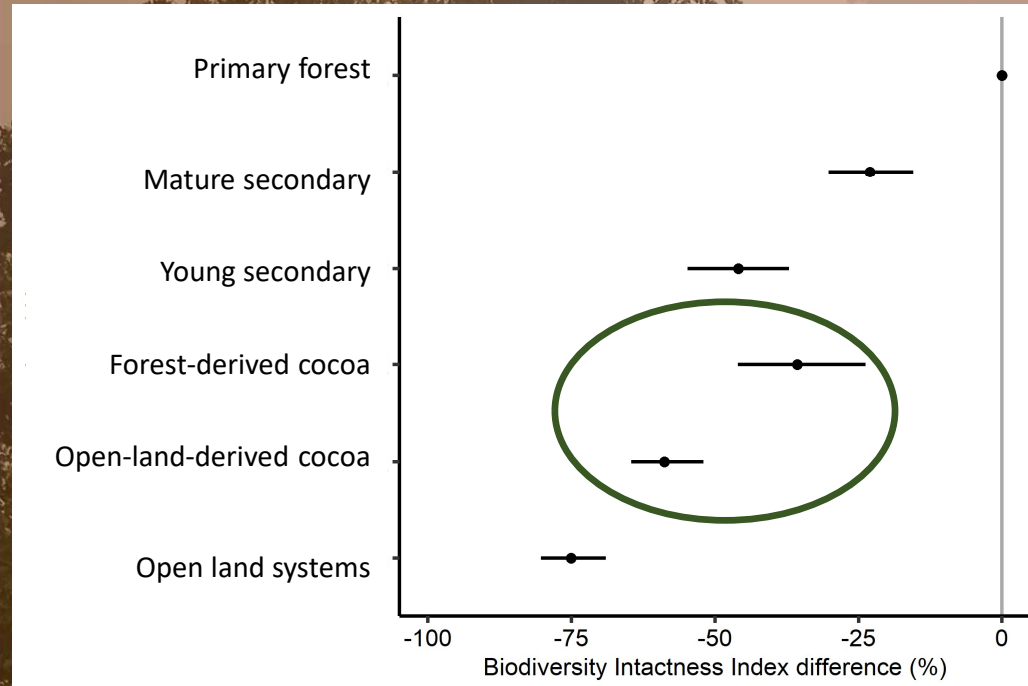
What biodiversity is in cocoa?

- Some debate – though see our paper for a synthetic summary
- Linked to system design, landscape, and historical context

Why biodiversity in cocoa?

- Climate biodiversity co-benefits
- Connectivity/refugia for vulnerable species
- Ecosystem services to farmers & beyond

Can we improve this model?



Maney, Sassen, and Hill, 2022

Conceptual framework: what drives biodiversity?

Plantation design & management



Tree species richness

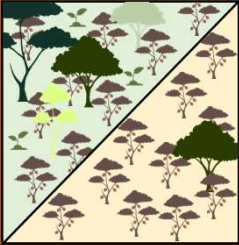
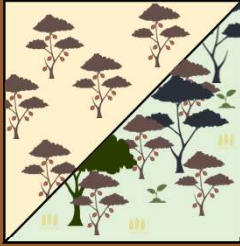
Phylogenetic diversity

Supporting services

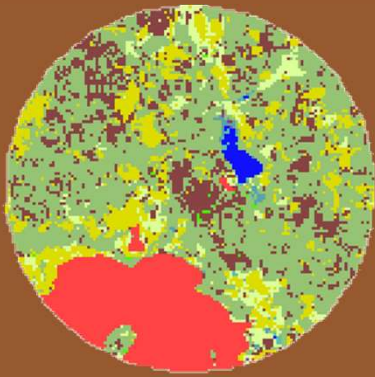
Understorey plant diversity

Functional diversity

Vegetation structure



Land-use history



Landscape effects

This work

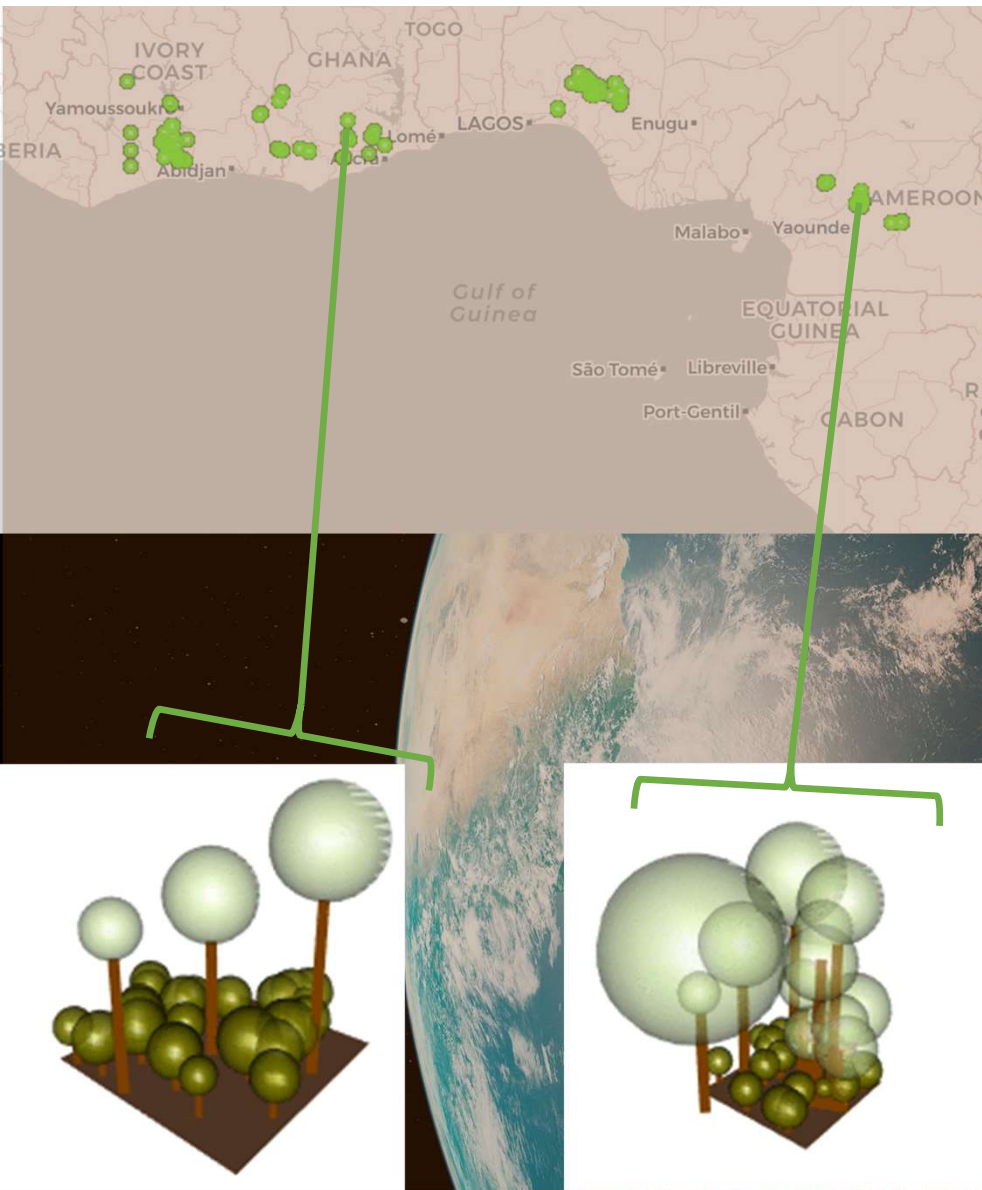
These questions are challenging to answer:

Biodiversity surveys are often small-scope, at a few locations and within one climatic zone/country

Agronomic information (management, conditions, outcomes) is often not available to pair with ecological information

“Piggy-backing” on an existing agronomic study to co-measure agricultural information, biodiversity surveys, interviews





Survey locations

Total farms – 169; 49 in Côte d'Ivoire, 38 in Ghana, 40 in Nigeria, 42 in Cameroon

Selection stratified by

Region

Rainfall

Landscape tree cover

(Practicality!)

Surveys at each site

Tree survey

Understorey plant survey

Leaf litter measurements

Interviews

Basemap: OpenStreetMap.

The designations employed and the presentation of material on the above map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

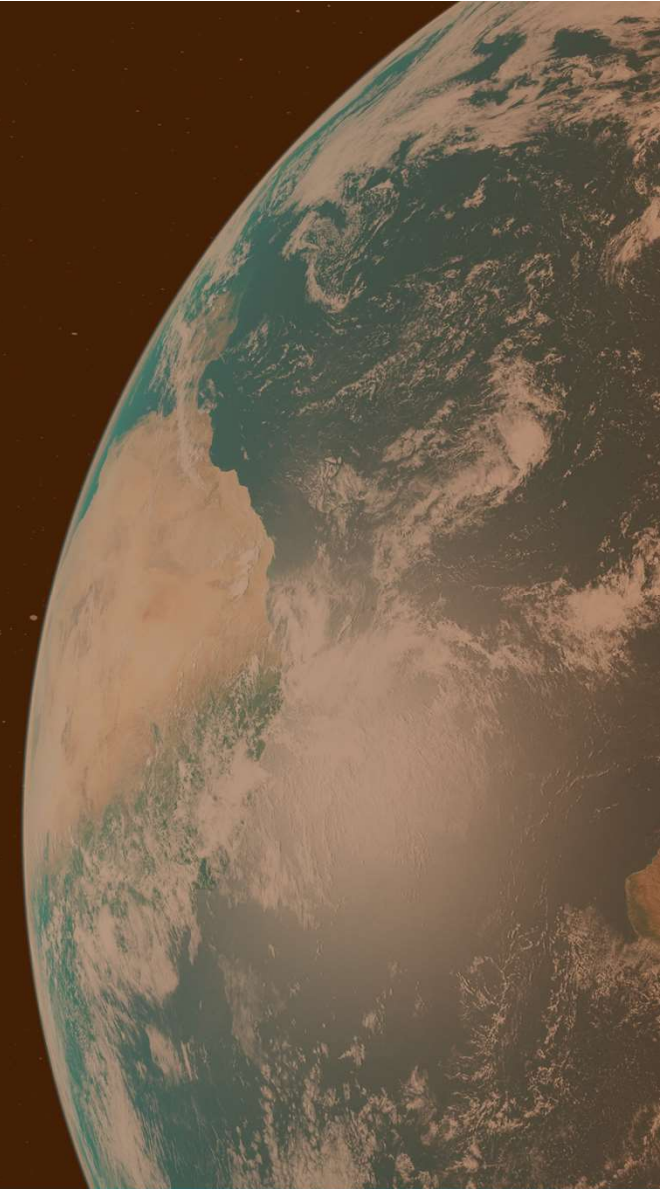
Approach: modelling

Path analysis approach – identify direct and indirect effects on biodiversity

Piecewise SEM (local estimation)

Hypothesis-based approach, starting with most confident/direct relationships and building up

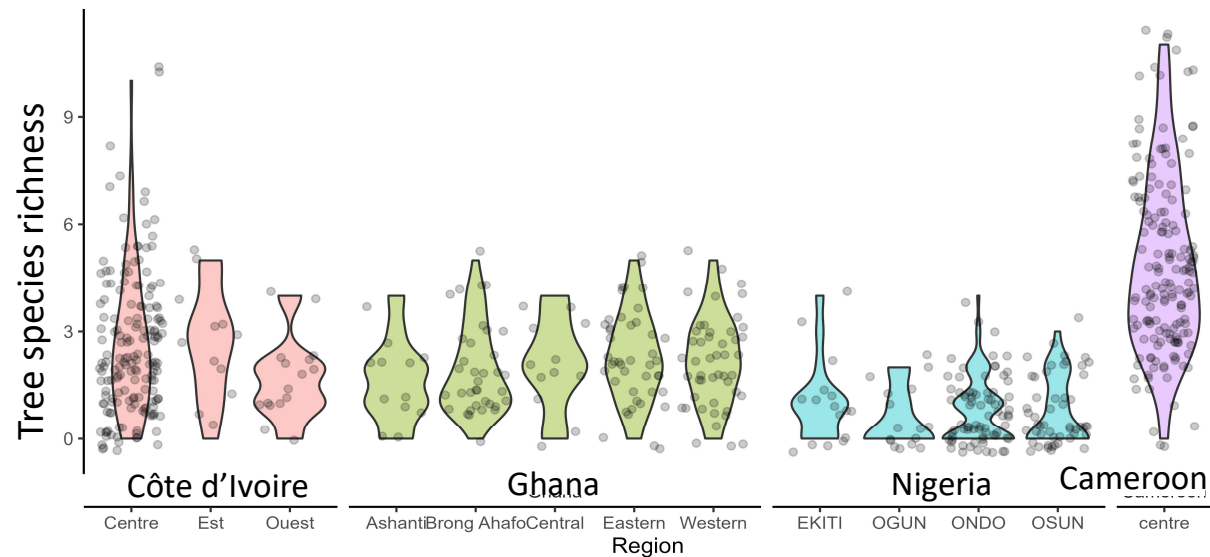
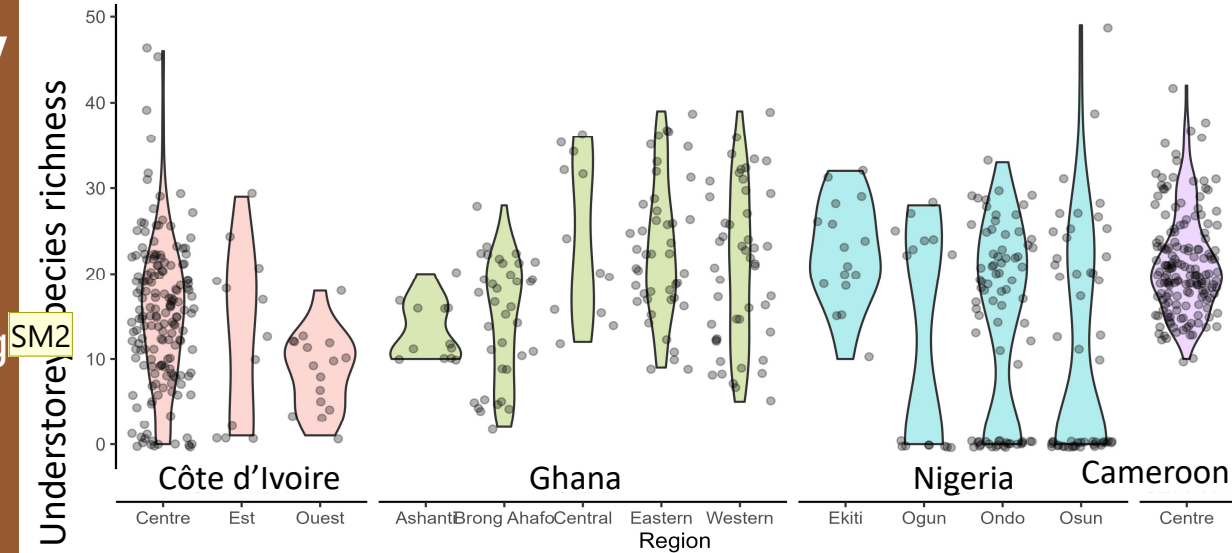
1. Biodiversity reinforcing
2. Abiotic conditions
3. Landscape effects
4. Management interventions
5. Land-use history mediation



Results: biodiversity patterns

Understorey diversity differed less among countries, though Nigeria had a larger proportion of samples with no understorey plants present.

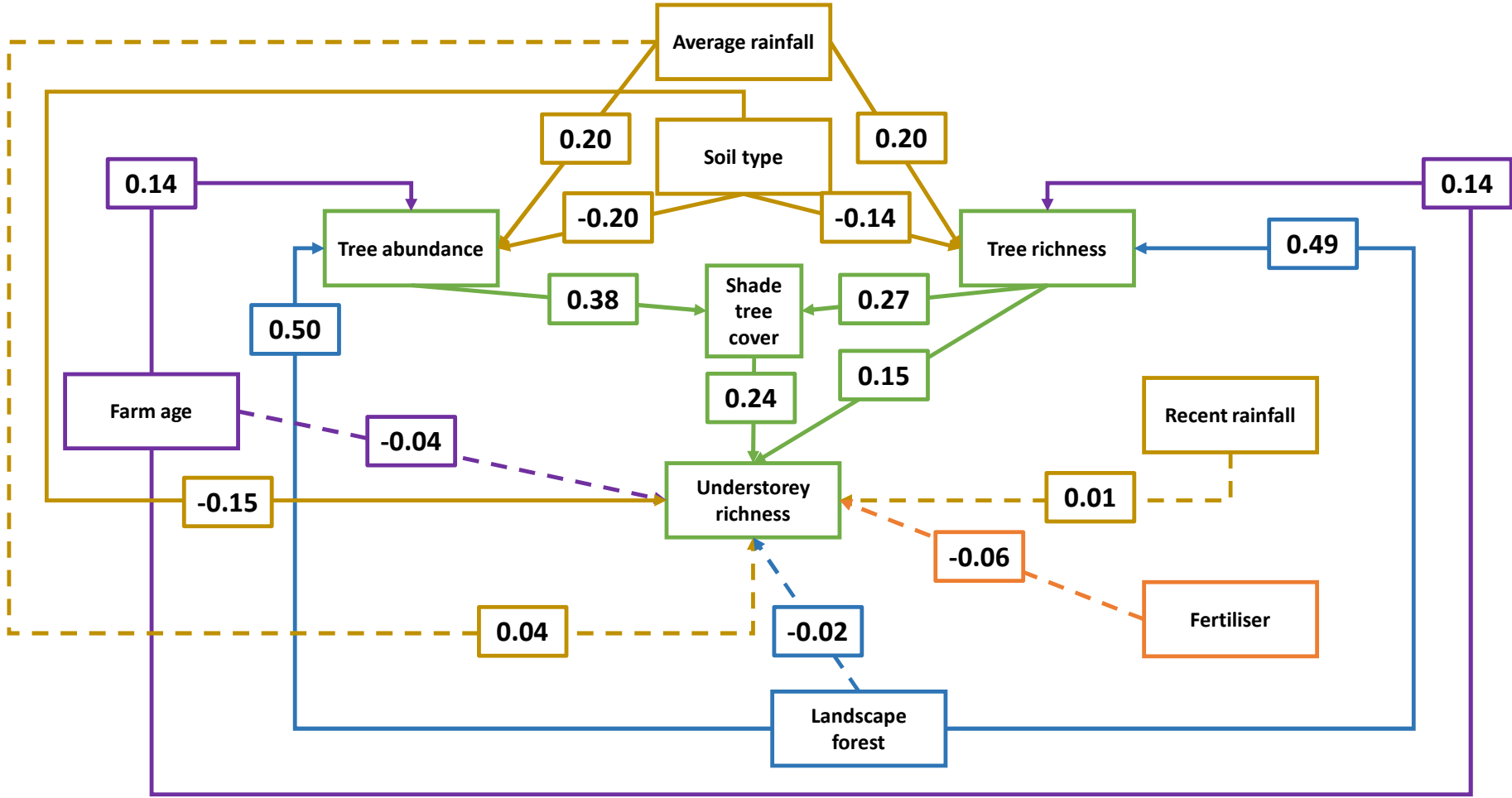
Tree biodiversity was richest in Cameroon. Côte d'Ivoire and Ghana had intermediate tree richness, with the Central region particularly rich. Nigeria had relatively low tree richness.



Slide 8

- GK0** I changed "trees to Tree biodiversity, "between" to "among" and higher to larger...
Giller, Ken, 2023-12-01T07:43:24.690
- GK1** can you make the text in the figure larger? At least country names and y axis? This will not be readable at distance
Giller, Ken, 2023-12-01T07:46:56.304
- SM2** The order in the text (tree then understory) is reversed from the figures (understory on top). Better swap around?
Sassen, Marieke, 2023-12-01T14:21:24.526

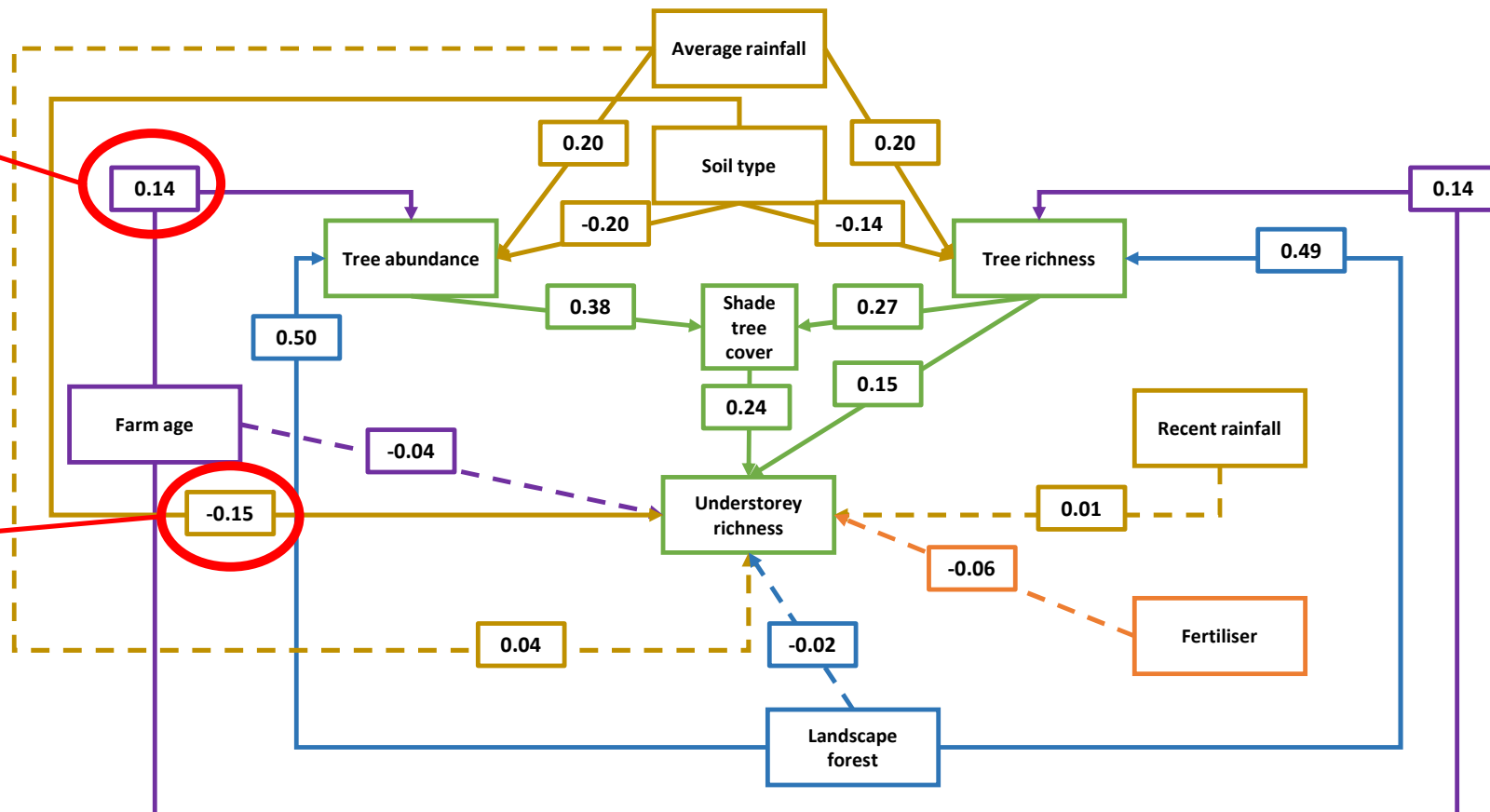
Model results:



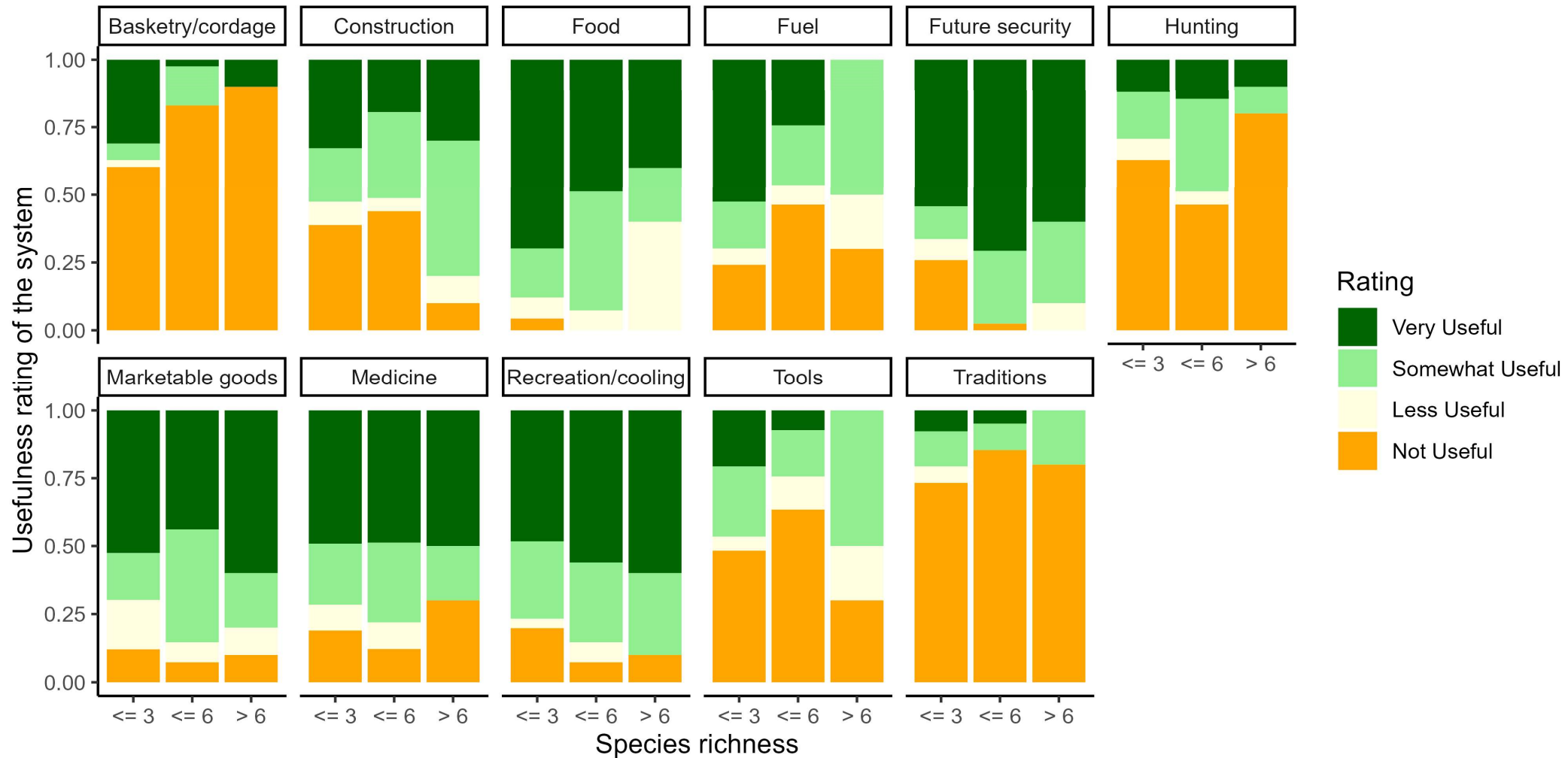
Model results mediated by land-use history

Positive in open-land-system-derived agroforests; negative in forest-derived agroforests.

Biodiversity in sandier soils was richer in open-land derived systems; but less rich in forest-derived systems.

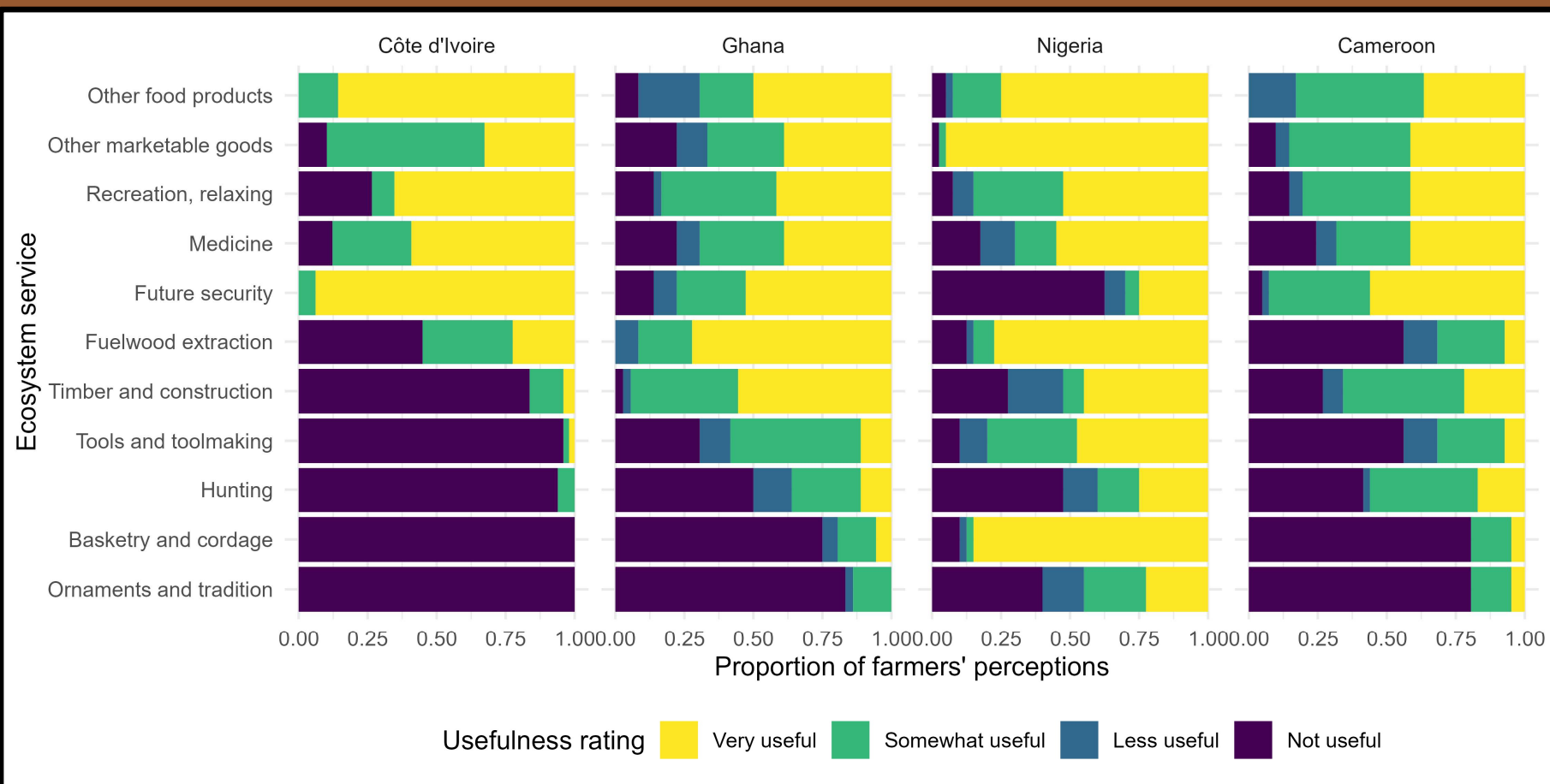


Results: ecosystem services



Why? Underlying drivers

What types of multifunctionality are important to farmers in each country?



Takeaways and extensions

We can picture what “biodiversity-friendly” cocoa looks like in terms of design and management, landscape and connectivity, and context-specificity

Further, specific types of biodiversity lead to benefits.

Extension: Going beyond plants now may tell use more about contributions to ecosystem services.

Thought: what are the implications of the EU Deforestation Regulation for cocoa and biodiversity?

GK1

GK0



Slide 13

GK0 give EUDR in full

Giller, Ken, 2023-12-01T07:52:33.405

GK1 Condense -

We can picture what "biodiversity-friendly" cocoa looks like in terms of design and management, landscape and connectivity, and context-specificity.

We can understand how (specific types of) biodiversity lead to expected benefits

Giller, Ken, 2023-12-01T07:55:01.315

Thank you!

Contact me: calum.maney@wur.nl



WCMC



Protocols: biodiversity

Tree diversity

- All trees above cocoa canopy
- Measurements taken and placement recorded (for spatial modelling)
- Benefits, disadvantages, and origins discussed with farmer

Understorey (herb) diversity

- 21m x 5 m transects
- Benefits, disadvantages, and origins discussed with farmer

**3,340 depth
measurements...**

**...2,258 shade
trees...**

**...and 200,000
understorey plants**

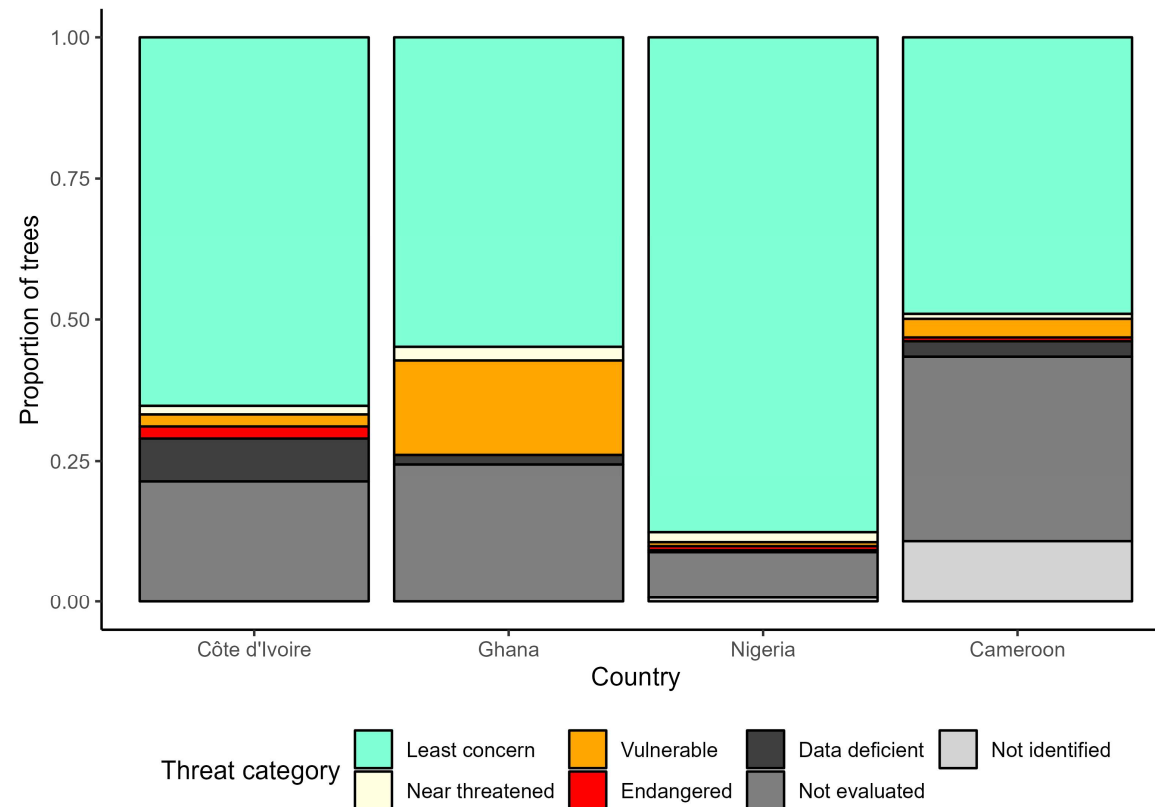
Results: biodiversity patterns

Over half of trees “Least Concern”; higher than averages across all of the Red List

But – 24 species are threatened to some degree

GK0

Terminalia ivorensis, *Entandrophragma angolense*, and *Sterculia oblonga* were among the most prevalent threatened tree species.



Slide 16

GK0 give an example or two of rare or endangered species?

Giller, Ken, 2023-12-01T07:47:52.743

CM0 0 The species below are the most prevalent threatened species - but this was not clear yet, thanks!

Calum Maney, 2023-12-01T09:10:33.117