Cocoa agroforestry systems and climate change mitigation

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18 May 2021
Forests, cocoa and carbon
-love and hate story-

• 15-88% of forest carbon is lost when replacing natural forests with cocoa

• Cocoa plantations store an average 50 Mg C ha\(^{-1}\)
  range 30 – 130 Mg C ha\(^{-1}\) aboveground

• Carbon footprint of cocoa is positive: captures > emissions

• Cocoa production typologies determine amount of C retained
Coffee/cocoa cultivation systems are classified into six broad, shade canopy and crop management typologies.
Trees are (usually) taller than cocoa

More trees = more carbon

More carbon = more shade

More shade = lower cocoa yields
Key question

• Can a high C cocoa plantation produce high cocoa yields and conserve biodiversity?

• To answer this question we need to:
  1. Determine how C is distributed between cocoa and shade canopy in every cocoa typology
  2. Evaluate key interactions between carbon levels and yields for every cocoa typology
No recipes for the ideal shade canopy!!!

To decide...we need to systematically evaluate some 20 key variables....

Implications for research...and for communication with farmers!!!!!
The shade canopy is a volume...the goal is to "optimally fill it up" with proper shade canopy plants.

Methodology

1. Determine farmers' objectives
2. Evaluate plantation status
   1. Self-shading: age, spacing, variety, pruning
   2. Crop phenology
   3. Canopy cover spatial homogeneity
3. Evaluate site conditions
   1. Soil fertility and water availability
   2. Latitude, exposure, slopes
   3. Nearby vegetation – lateral shade
   4. Wind, clouds
4. Evaluate tree species
   1. Use
   2. Crown characteristics: diameter, density, phenology
   3. Tree height

Designing optimal shaded coffee Agroforestry systems

Image: Shade canopies.

Website: www.shademotion.net
High C, high yielding, species-rich cocoa shade canopies

- C can be increased by using tall trees ("sequoia type")
  - Small crowned, sequoia type trees can allow for higher species richness
  - Tall trees cast "light shade" over cocoa

- Key morphological and functional traits of tree species
  - Small foliage (e.g. Mimosoideae) transmit more solar radiation to understorey
  - Species with reversed phenology (e.g. shade leaves in rainy, cloudy months) may allow for better transmission of solar radiation
Research gaps & Development needs

- Demonstrate: shade trees are compatible with intensification of cocoa cultivation
- A must: **Optimal design** of profitable and resilient cocoa production systems
  - Options x Context approach
  - Genotype x Environment research
- Adjust **university and farmers’ field school curricula**
Thank you