Using the Cool Farm Tool to benchmark the climate change mitigation potential of cocoa systems

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Introduction

Cocoa supply

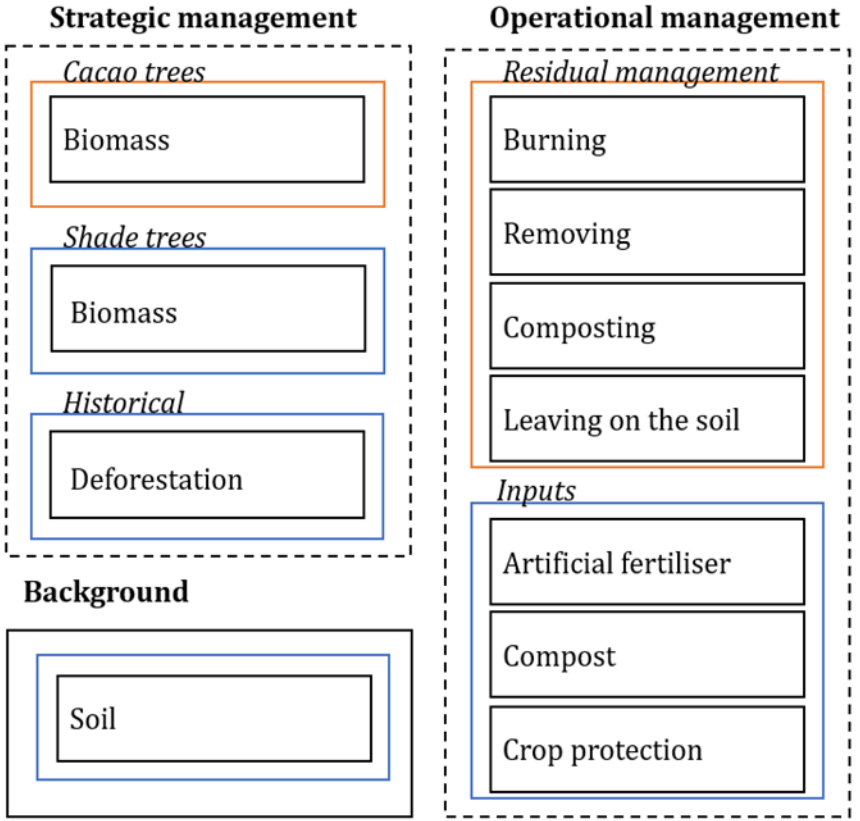
- Need to change towards low GHG emissions for climate change mitigation
- Carbon credits may be new/additional income source for smallholders

Aim of the studies

- Quantify current GHG-emissions associated with cacao production
- Understanding the relation between management and GHG-emissions
- Investigate whether high yields, high carbon stocks and low GHG emissions are compatible in cocoa production

Modelling

- Cool Farm Tool
  - Shade tree biomass
  - Deforestation
  - Inputs
  - Background
- Perennial GHG model
  - Cacao tree biomass
  - Residue management



Data sources for Study 1

- Literature — *Cacao and shade tree biomass (32 papers)*
- UTZ survey — *Farm management on 509 fields in Côte d'Ivoire*
- Fieldwork — *Fruit and pruning data from CNRA station in Divo*

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Figure adapted from: https://www.researchgate.net/figure/Horizontal-and-vertical-structure-in-a-mixed-shade-canopy-cocoa-based-agroforestry_fig2_322936307

Data from UTZ survey

	Left on the field	Composted	Burnt	Farm output
Pruning residues	90%	0%	0%	10%
Cacao husks	73%	24%	0%	4%
Infected fruits	74%	8%	6%	30%

- Cacao trees are pruned in almost all of the plots (93%)
- Almost all of the respondents (88%) report that they have infected fruits
- Compost is applied in 26% of the cacao plots
- Other fertilisers applied in very small amounts in 60% of the cacao plots

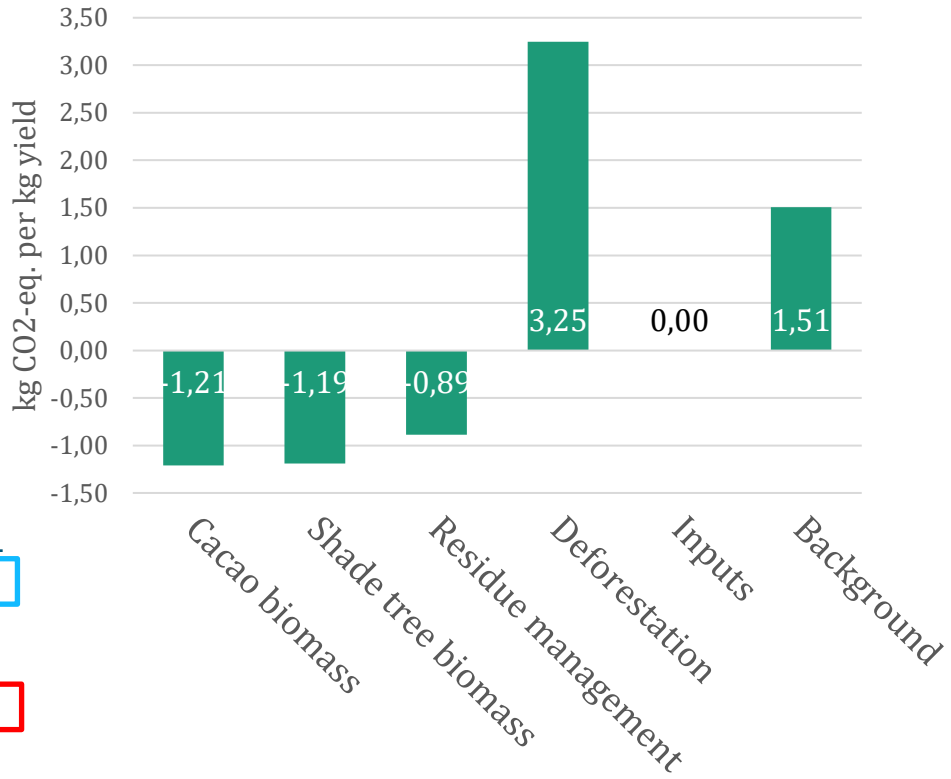
Results from modelling

Carbon stock

- Shade trees: 4 ton C/ha
- Cacao trees: 19 ton C/ha

GHG emissions

Management	CO_2eq / kg beans
Actual UTZ plus deforestation	1.47
GAP plus deforestation	2.29
Actual UTZ no deforestation	-2.22



Source: Vervuurt et al, 2022. DOI.org/10.1007/s10457-022-00729-8

Climate-friendly cacao (Q1)

Characteristics climate friendly plots:

- Higher age cocoa trees
- Higher bean yield per hectare
- Residues are left in the field
- Higher number of shade trees

Producing high yields, storing a high amount of carbon in standing biomass and causing low GHG emissions/ha simultaneously is feasible (Q1)

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Source: Vervuurt et al, 2022. DOI.org/10.1007/s10457-022-00729-8

Comparing different locations: Study 2

- Deforestation is excluded, only cultivation phase is considered, hence negative emissions (sequestration in trees) expected (-2.22 CO2eq/kg in CdI in study 1)

	Cameroun		Ghana		Côte d'Ivoire		Indonesia	
Number of farmers	878		455		298		947	
Period	baseline	endline	baseline	endline	baseline	endline	baseline	endline
Emission [CO2eq kg/kg beans]	-31.4	-23.5	-42.3	-35.5	-8.7	-4.9	6.3	-7.4

- Cameroun & Ghana have more shade trees (largest sequestration) in baseline; increased fertiliser use & bean yield in endline (lower sequestration/kg beans)
- Indonesia used more compost & N fertiliser than other countries in baseline (net emissions); reduced fertiliser in endline while yield stabilised (net sequestration)

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Sources of inaccuracies & suggestions for improvement

- Input data
  - Most **data are asked** leading to some **inaccuracies** in input data (e.g. on shade trees) → some measurements
  - Every company asks questions **slightly differently** → difficult for comparison across companies → standardization
- Some CFT model coefficients and equations
  - are less accurate due to lack of measured data → measure
  - are default settings and lack adjustment to specific conditions → contextualize

Suggestions for improvement of CFT tool

- **N_2O emissions** need to be measured for all nutrient management practices (fertiliser, compost, residues) as current default values are to low, linear increase is assumed with higher fertiliser supply, and only 2R instead of 4R accounted for.
- **Pruning** biomass amount, wood-leaf ratios and effect of pruning on carbon storage at tree and at soil level need improved assessment
- Contribution of **roots** to soil carbon still poorly understood
- Current cocoa **crop growth** is based on potential growth **curves** but growth may be nutrient/water limited → overestimation of C seq.

The good news is that actions are taken to address these points!!

Conclusion

- CFT can be used for benchmarking between cultivation systems when based on **similar** (method) and **complete** input data collection; Some input data need **measurements** to increase accuracy
- Need to optimise nutrient supply & shade levels for yield and carbon sequestr.
- For absolute numbers some of the CFT coefficients/equations need **adaptation** through further **research** → pre-competitive research in https://CocoaSoils.org
- When absolute CO_2 eq numbers are known the tool can
    - advise practices with **better yield & carbon outcomes** to smallholders & contribute to climate change mitigation
    - underpin payment of **carbon credits** to smallholder farmers **increasing their income** from cocoa production

Thanks for your attention

It is for their future!!

Thanks to:
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