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Sys Com Bolivia

Cocoa and by-crop yields in three organic production systems entering mature stage

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Instituto de Ecología

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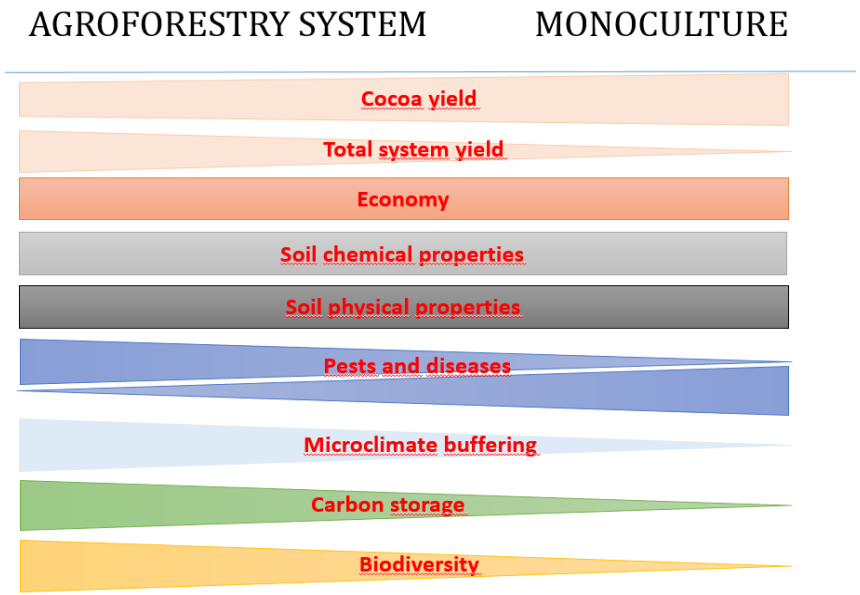
Agroforestry for cocoa has environmental benefits



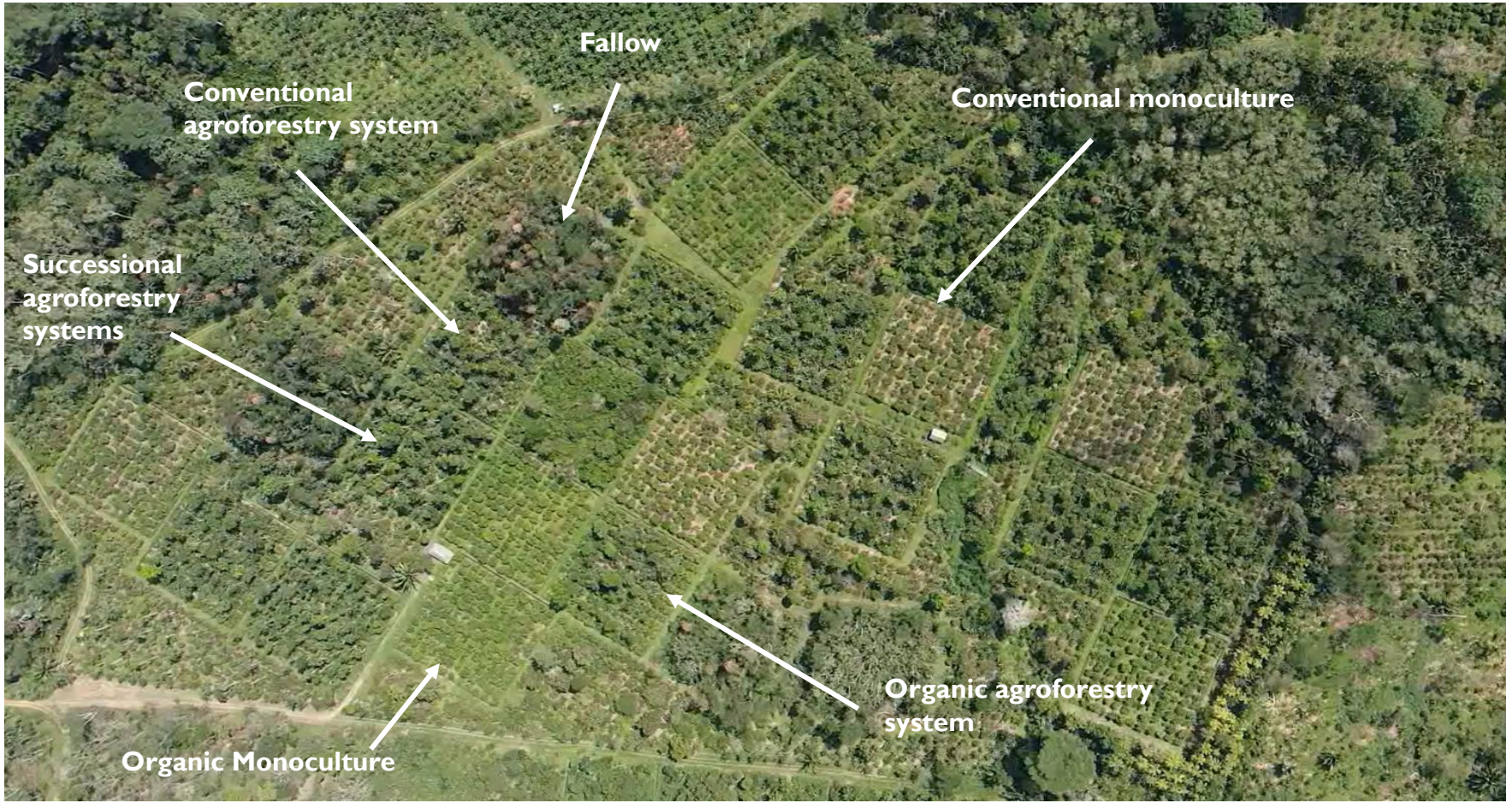
Niether et al. 2020 *Environ. Res. Lett.* **15 104085**

SysCom Bolivia Project

Objectives

- Do **agroforestry systems** and **organic management** perform better (**agronomical, socio-economic** and **environmental** indicators) compared with monocultures and conventional farming?
- What are the **challenges** of the different production systems?

- Start: End of 2008
- 5 different systems compared, replicated 4 times
- Plots measuring 48 m x 48 m
- 12 cacao cultivars, planted at 4 x 4 m
- 144 cocoa trees monitored per plot (2880 trees in total) every 2 weeks



Picture: Eric Lohse

Gradient of diversity of organic production systems

Monoculture MONO ORG

Compost (21 L/tree)
Cover crop/herbal cover
Mechanical weeding

Temporal shade: plantain

Agroforestry AF ORG

Compost until 2016 (10 L/tree)
Cover crop in beginning
Mechanical weeding
Regular shade tree pruning
Temporal shade: plantain, trees

Successional or dynamic agroforestry SAFS

No external inputs
Selective weeding & natural regeneration
Regular shade tree pruning
Temporal shade: plantain, trees
annual crops (cassava, maize, …)

Agroforestry designs

Agroforests (About 300 shade trees/ha)

- Plantain (4 x 4 m) for the 3 first years
- Since 2012 banana (4 x4 m)
- Since 2016 coffee (4 x 2 m)x2
- Leguminous trees (8x8 m)
- Fruit and timber trees (16 x16 m)

→ 5 timber species, 4 fruit species, 2 biomass species, 1 palm

Successional agroforests (About 800 shade trees/ha)

- Plantain (4 x 4 m) for the 3 first years
- Anual and short-life cycle crops
- Since 2012 banana (8x8 m)
- Since 2013 coffee (4 x 2 m)x2
- Ginger and curcuma

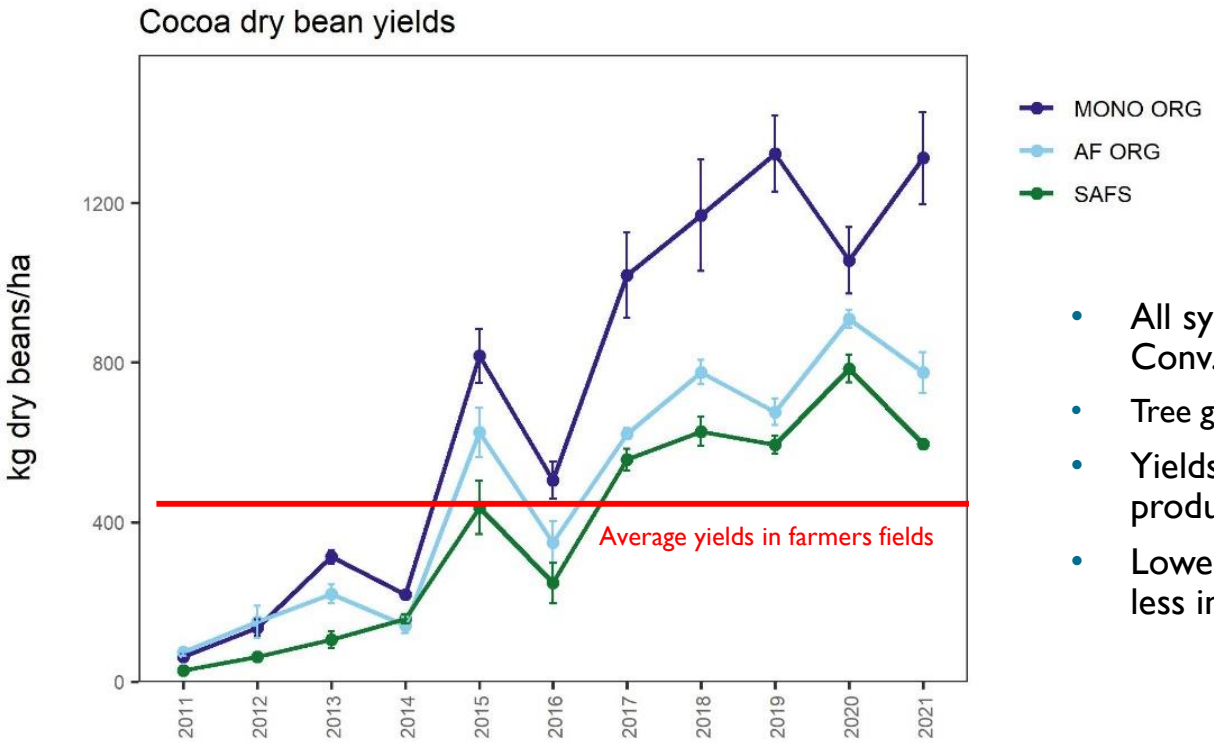
→ ~19 timber species, 4 banana varieties, ~ 8 fruit species, ~20 biomass species, 3 palms

→ Natural regeneration of some species

→ Shade tree density changing over time

→ Different strata and life cycles

Cocoa yield development

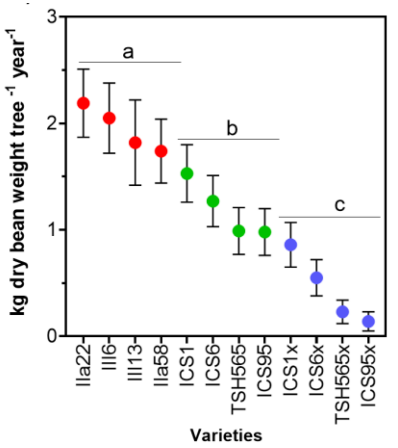


n=4, errorr bars represent standard error

- All systems started slowly (compared to Conv. not shown)
- Tree growth in AF/SAFS slower
- Yields in AF and SAFS are higher than producers in many places
- Lower yields in denser systems and with less inputs

Cocoa yields in mature plantations depending on varieties

mean dry bean yields [kg/ha] between 2018 - 2021			
	MONO ORG	AF ORG	SAFS
all 12 varieties	1213.6	781.4	648.9
4 local clones	1845.1	1140.5	975.1

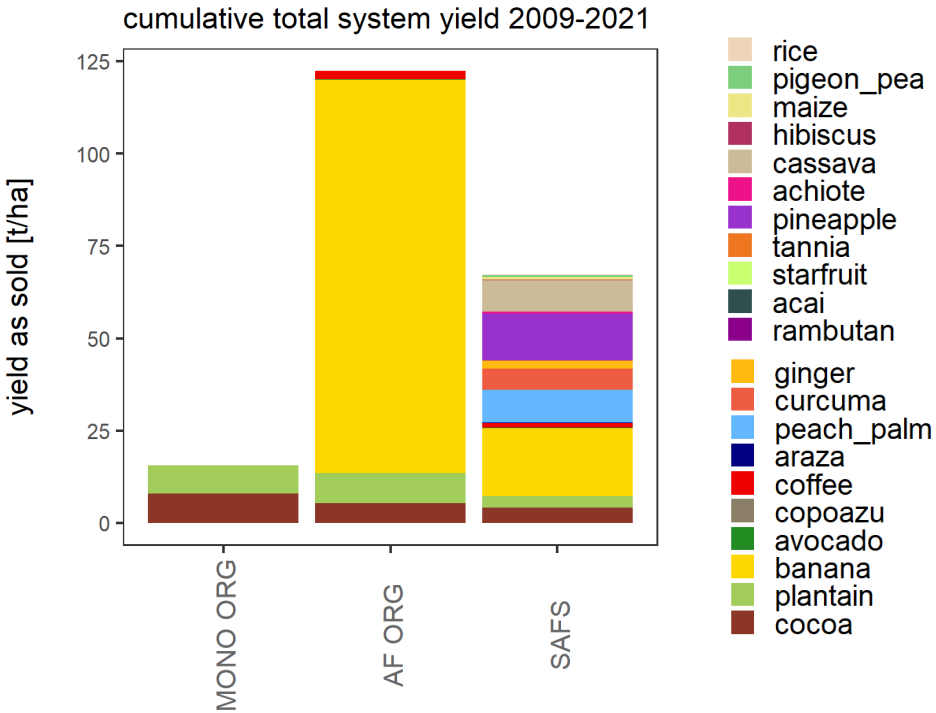


- Local clones
- International clones
- Full-sib families (xIMC67)

2015 - 2019
Picucci et. al, unpublished

- → Participatory selection process of el Ceibo selecting locally adapted clones, tolerant to diseases
- → Cocoa yields in MONO are 1.9 (SAFS) and 1.6 (AF) times higher
- → No systems effect
- → Breeding for agroforestry

Cumulative total system yields

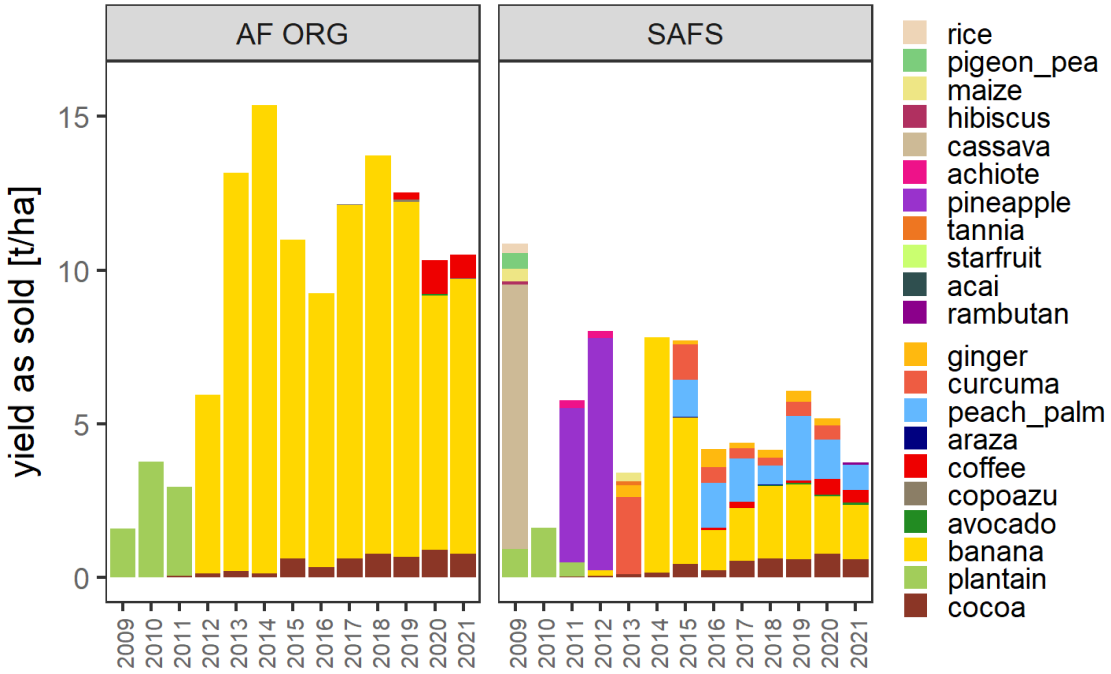


cocoa dry beans, coffee dry parchment,fruit as fresh weight, plantain/banana withut peduncle

→ Total system yields in 7.8 (AF) and 4.3 (SAFS) times higher than in MONO

→ SAFS lower total yields than AF, but higher diversity

How do AF and SAFS differ in their development?



→ SAFS higher yields in young systems

→ AF higher yields in mature systems with 3 market oriented crops

→ Fruit trees, ginger and turmeric with potential

Conclusions for agroforestry design and income





Diversity of crops for income

- Income strongly market dependent
- SAFS/temporal shade for quick income
- Diversity intresting for distribution of income over year
- Strategy to be ready for markets in the future (Emerging markets (Acai, Rambutan, Copoazu))
- Interesting for self-consumption (avoiding costs)

Optimization of the design depending on

- Specific goals (input or labour time intensive, extensive, economic, nutrition, …)
- Ressources and market opportunities

Conclusions for agroforestry management

Reducing shade trees over time vs. fixed design

- Selection of productive fruit and good quality timber trees
- Growth of timber trees
- Risk distribution for loss of fruit trees

Regular shade tree pruning

- Can replace external fertilizers
- Allows for high density of shade trees while reaching good cocoa yields

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