The contribution of cocoa agroforestry on yields, soil, pests, biodiversity and climate change:

a multi-dimensional meta-analysis

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Meta-analysis: comparing cocoa...
World map: research on cocoa agroforestry per country

- 52 articles with direct comparisons
- 144 sub-studies
- 93 data pairs (independent pairwise comparisons)
Multi-dimensional

- Yield
- Economy
- Soil chemical properties
- Soil physical properties
- Pests and diseases
- Microclimate
- Stand structure
- Biodiversity

AGRO-FORESTRY versus MONO-CULTURE
Multi-dimensional

Yield
Costs, system revenue, net present value
AGRO-FORESTRY
Cocoa, system yield

Economy
C, N, Pav, Kav, SOC, pH

Soil chemical properties
Mean weight diameter, bulk density, volumetric water content,

Soil physical properties

Pests and diseases
Fungal diseases

Microclimate
Temperature, humidity, vapor pressure deficit

Stand structure
Basal area + carbon storage in cocoa and trees

Biodiversity
Animal wildlife + herbal plants

MONO-CULTURE
Results: Yield

- Higher cocoa yield in monocultures
- Higher system yield in agroforestry systems
Cocoa yield

Total system yield
Results: Economic performance

No significant differences between monocultures and agroforestry systems
AGROFORESTRY SYSTEM  MONOCULTURE

Cocoa yield

Total system yield

Economy

Soil chemical properties  C, N, P, K, SOC, pH

Soil physical properties  Mean weight diameter, bulk density, volumetric water content
Results: Pests and diseases

Effects depend on the nature of the disease
AGROFORESTRY SYSTEM

Cocoa yield

Total system yield

Economy

Soil chemical properties

Soil physical properties

Pests and diseases

MONOCULTURE
Results: Microclimate

Buffering of high temperature and low humidity under shade
Climate change adaptation
Results: Stand structure and carbon storage

More carbon storage above- and belowground in agroforestry

Mitigation of climate change → Carbon sequestration

Options for carbon offset?!
AGROFORESTRY SYSTEM

Cocoa yield
Total system yield
Economy
Soil chemical properties
Soil physical properties
Pests and diseases
Microclimate buffering
Carbon storage

MONOCULTURE
Results: Biodiversity

→ Higher species number in agroforestry systems

→ Number of herbal species depends rather on management (herbicides)

(Marconi and Armengot 2020)
AGROFORESTRY SYSTEM

Cocoa yield

Total system yield

Economy

Soil chemical properties

Soil physical properties

Pests and diseases

Microclimate buffering

Carbon storage

Biodiversity

MONOCULTURE
Agroforestry systems have the potential to compete with and even outperform monocultures.
Conclusions and implications (1)

- No definition of cocoa agroforestry beyond “inclusion of trees”

→ A global recommendation for shade levels or shade tree species would not be accurate (high heterogeneity of environmental, climatic, soil and socio-cultural conditions)
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- No definition of cocoa agroforestry beyond “inclusion of trees”

→ A global recommendation for shade levels or shade tree species would not be accurate (high heterogeneity of environmental, climatic, soil and socio-cultural conditions)

→ But: Local and context-specific knowledge and recommendations for cocoa agroforestry design and management needed

→ Knowledge gaps on species-specific information on shade trees, management strategies, pricing policies, livelihood aspects need to be addressed

Farmer-to-farmer field course, Bolivia (image: J. Jacobi)
Conclusions and implications (2)

- Management is crucial, but pesticides can threaten human health and environmental benefits

→ Alternative management strategies

Pruning to manage microclimatic conditions (images: W. Niether)
Conclusions and implications (3)

Even simple agroforestry systems can have positive effects. But they are not enough because:

I. food security and
II. environmental benefits need to be part of the calculation

→ social-ecological system approaches are necessary

Diversification of cocoa plots, El Ceibo, Bolivia (image: J. Jacobi)
Conclusions and implications (3)

Even simple agroforestry systems can have positive effects. But they are not enough because:

I. food security and
II. environmental benefits need to be part of the calculation

→ social-ecological system approaches are necessary

- Building and enabling access to new alternative markets and value chains for agroforestry products
→ (Real) incentives for farmers to plant trees

→ Deforestation for agroforestry is no option!
(also no carbon offset)

Diversification of cocoa plots, El Ceibo, Bolivia (image: J. Jacobi)

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THANK YOU
GRACIAS
MERCI

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