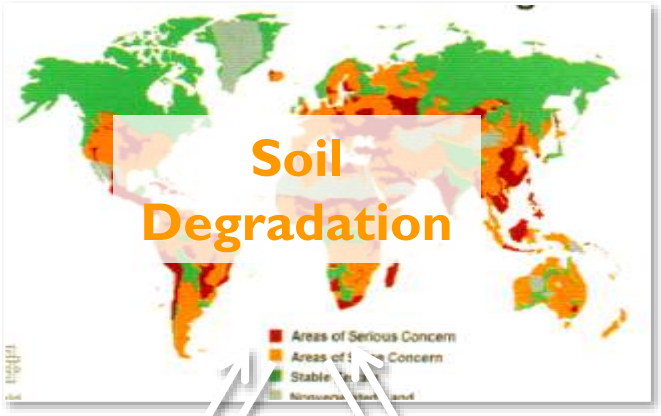
Research Institute of Organic Agriculture FiBL
info.suisse@fibl.org, www.fibl.org

The contribution of organic agriculture in the tropics to sustainable development

Beate Huber, Irene Kadzere, Christian Schader

Noah Adamtey, Laura Armengot, David Bautze, Johan Blockeel, Gurbir Bhullar, Harun Cicek, Christian Grovermann, Anja Heidenreich, Gian Nicolay, Amritbir Riar, Bernhard Schlatter, Monika Schneider, Brian Ssebunya

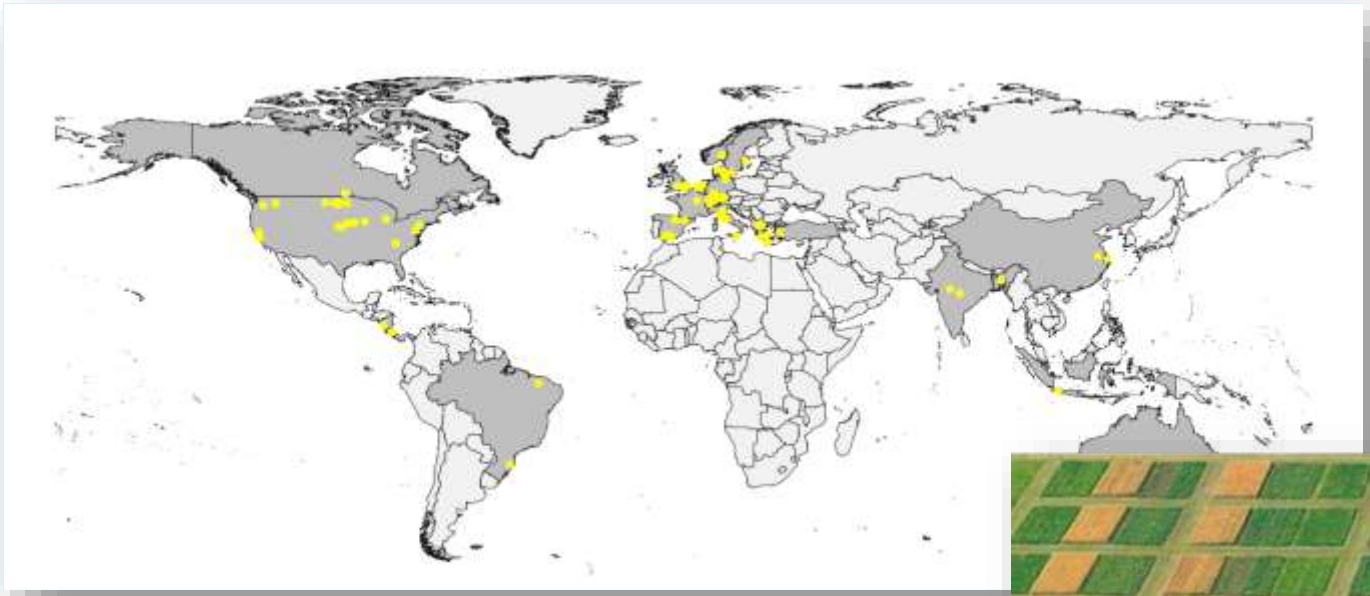
Global challenges



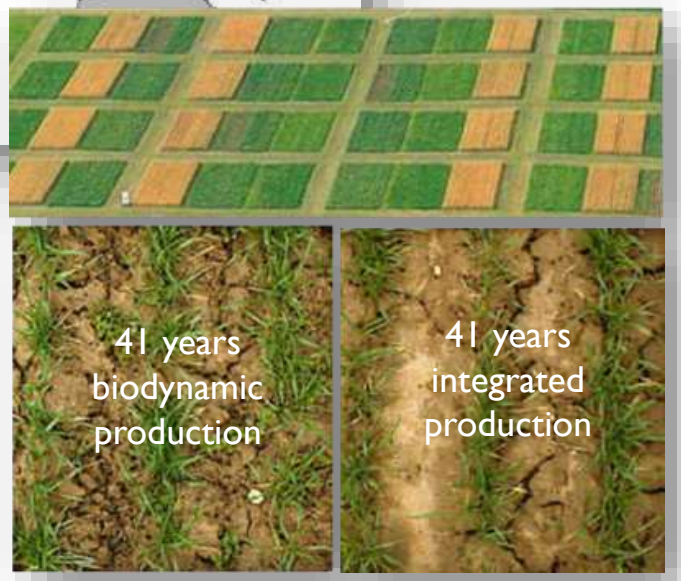
- Smallholders (<10 ha) manage 80% of the farmland in Sub-Saharan Africa and Asia, supplying most of the food in these regions.

Focus on research in Global North, eg soil fertility

- Meta-study on soil carbon with 74 global comparative studies



Source: Gattinger et al. 2012.



- FiBL long-term DOK trial proved higher top soil carbon values for organically farmed soils compared to nonorganic

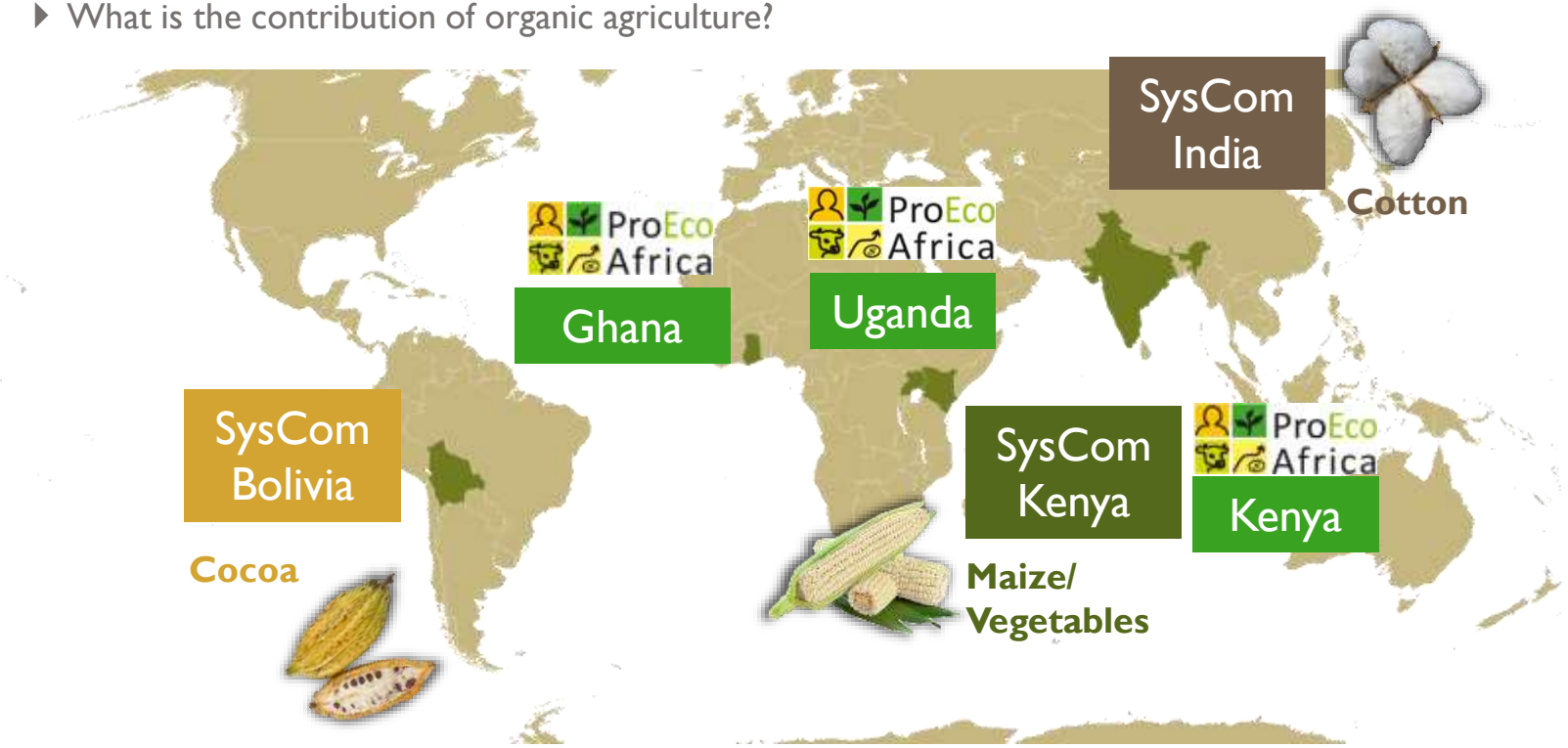
SysCom

Long-term Farming Systems Comparisons Trials in the Tropics

ProEcoAfrica/OFSA

Productivity, Profitability and Sustainability of Organic and Conventional Farming Systems: comparative analyses in Sub Saharan Africa

- What is the contribution of organic agriculture?



Content

SysCom

- Soil Fertility
- Biodiversity
- Productivity & Profitability

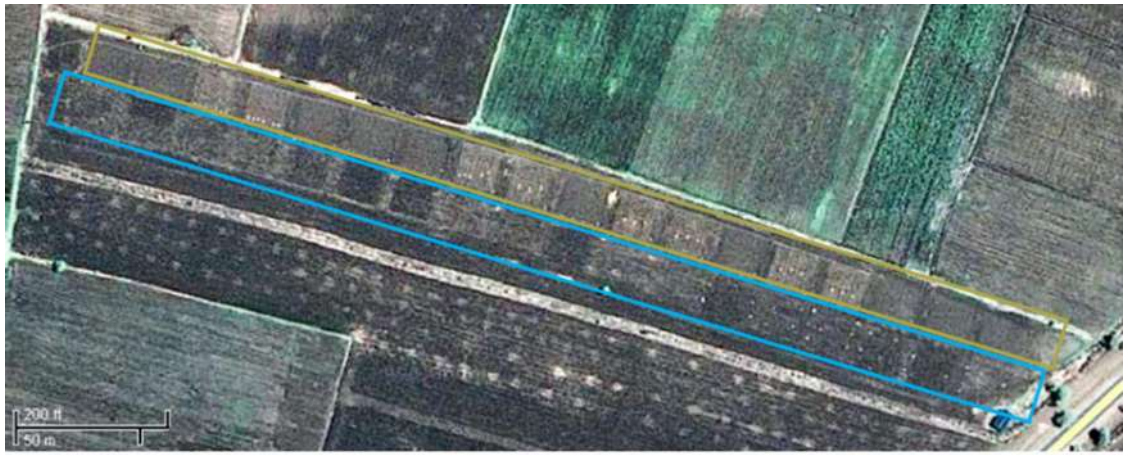
ProEcoAfrica/OFSA:

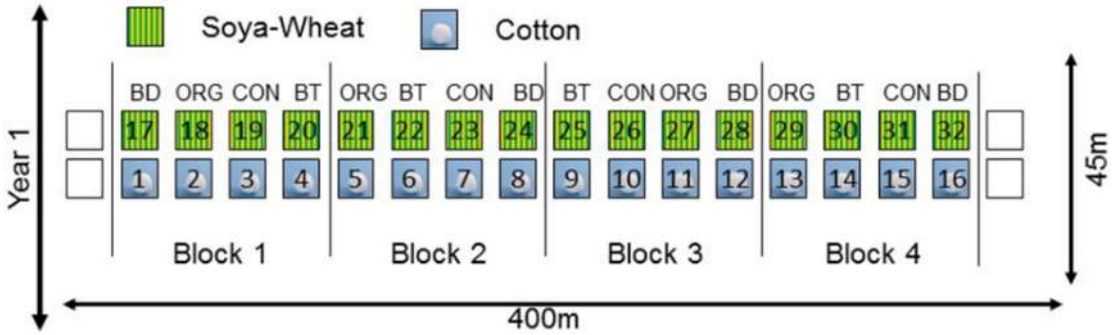
- Adoption of organic practices by farmers
- Productivity & Profitability
- Contribution to sustainable development

Conclusions

- Contribution of Organic Agriculture in the Tropics to Sustainability?

On-station trials India

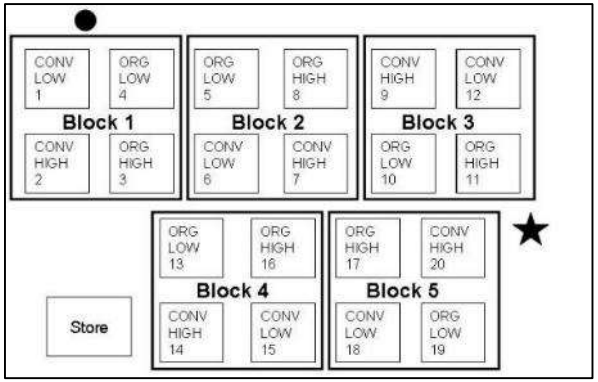


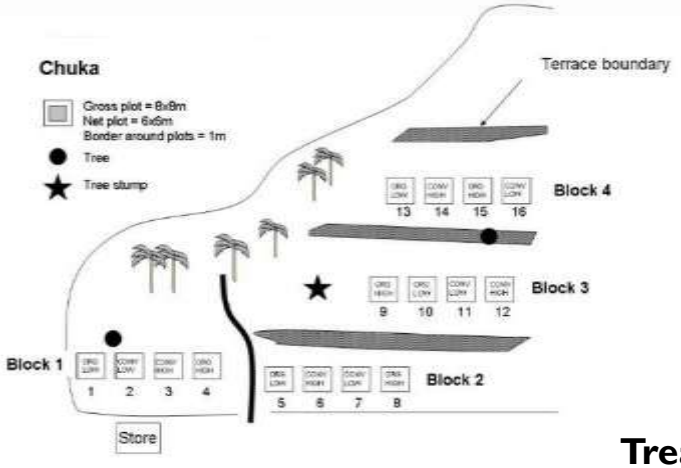


Treatments:

- BT Cotton (GMO)
- Conventional
- Organic
- Biodynamic

On-station trials Kenya





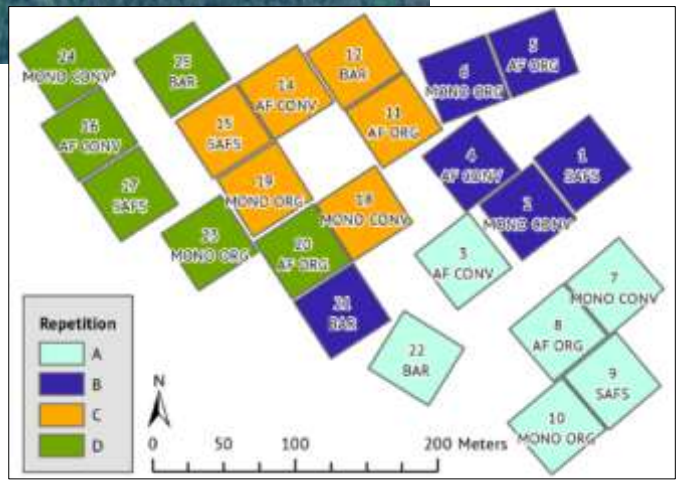
Treatments:

- Conventional, high input
- Conventional, low input
- Organic, high input
- Organic, low input

On-station trials Bolivia

Treatments:

- Conventional, monoculture
- Organic, monoculture
- Conventional, agroforestry
- Organic, agroforestry
- Organic, successional agroforestry
- Fallow



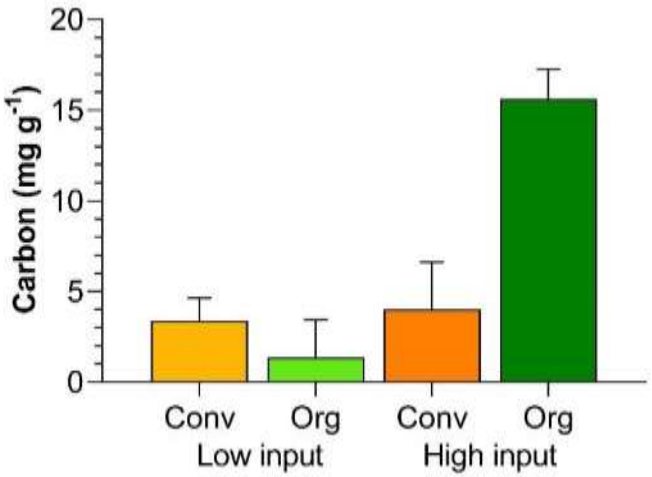
Results from Long-term Experiments (SysCom)

Soil fertility

- Soil organic carbon

Kenya

Soil carbon change (2007-2017)



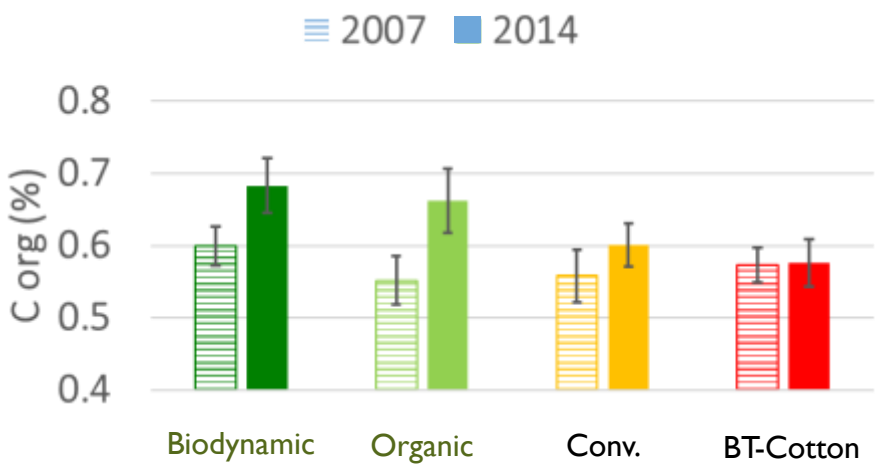
- Soil carbon in organic is higher in High Input systems compared to conventional
- Soil carbon is lowest in organic Low Input systems (soil depth 0-20cm)

Soil fertility

Soil organic carbon

India

Soil carbon change (2007-2014)



- No significant change in soil carbon in conventional systems
- Significant increase of soil carbon in organic systems – higher soil fertility

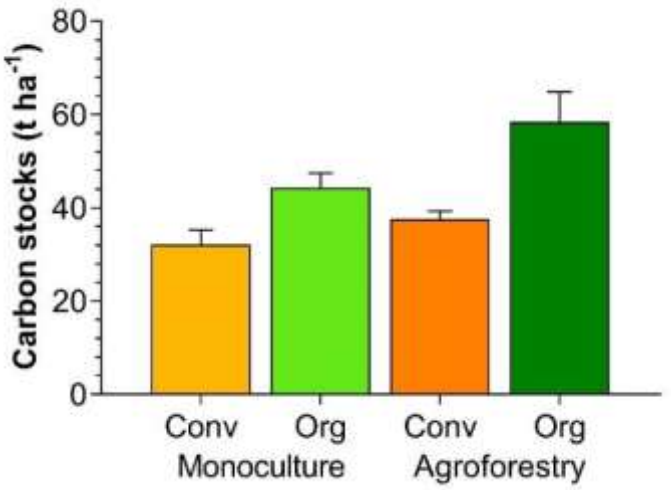
Application of manure: Conv. and BT: application of farm yard manure (conv 5 t every second year, plus NPK ; organic 8 t every year

Soil fertility

Soil organic carbon

Bolivia

Soil carbon stocks (2015; after 6 years)



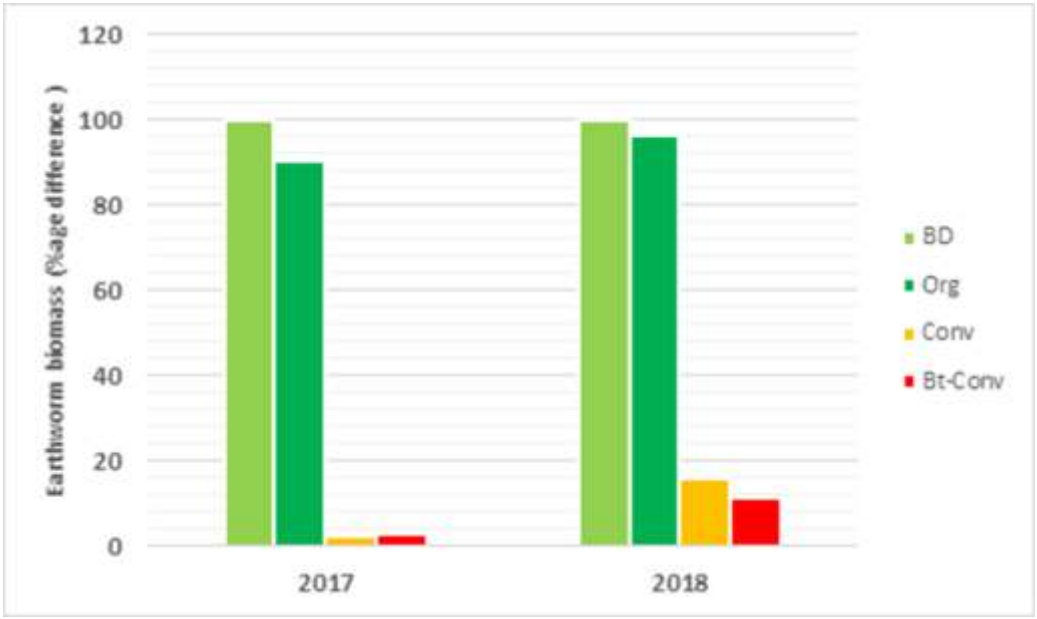
- Soil carbon in agroforestry and in organic systems is higher compared to monocultures / conventional
  (soil depth 0-10cm)

Biodiversity Conservation

Earthworm biomass

India

Density of earthworms during cotton season (per m^2)



- Density and biomass of earthworms in organically managed soils much higher.
- Earthworms contribute to soil stability and fertility

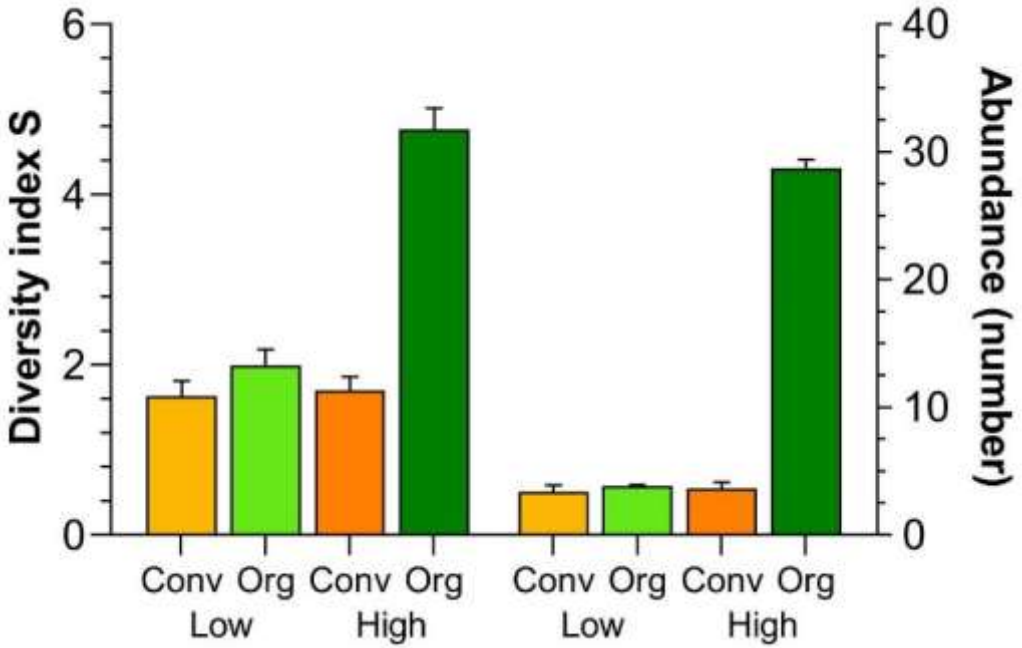
Source: Ledroit et al. (unpublished)

Biodiversity conservation

Termites

Kenya

Diversity and abundance of termites (3 seasons per plot)



- More diversity and abundance of termites in organic high input production system
- Termites contribute to soil stability and fertility

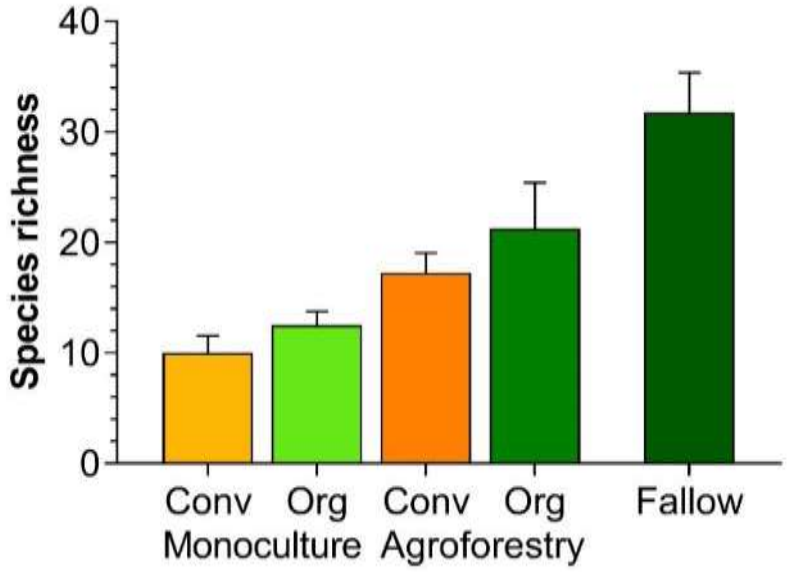
Source: Anyango et al. (unpublished)

Biodiversity conservation

Birds

Bolivia

Species richness of birds



- Agroforestry production systems have higher species richness of bird species compared to monocultures.
- Agroforestry is lower compared to fallow (secondary forest) of the same age.

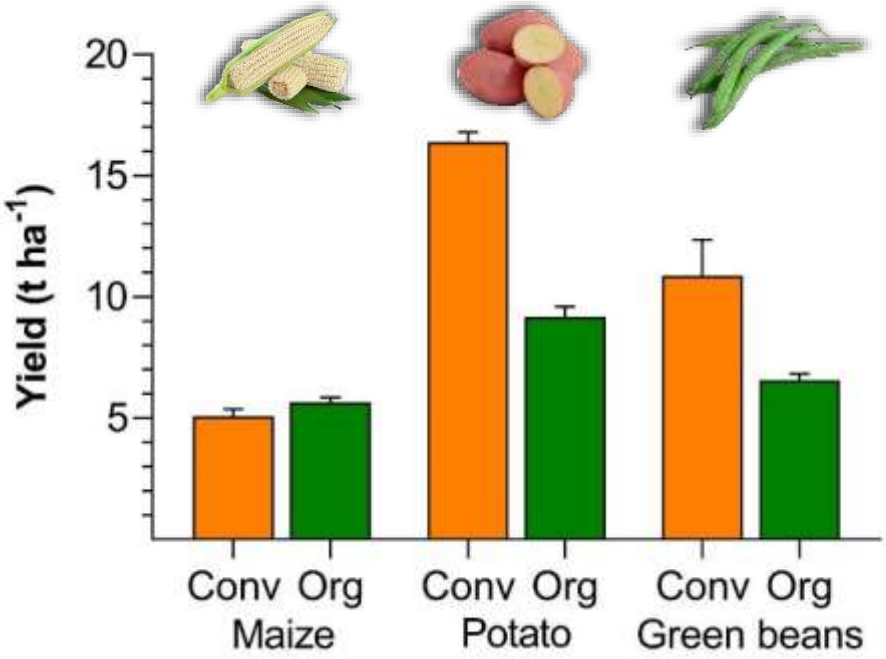
Source: Naoki et al. (2017)

Yields

- Crop yields in high input systems

Kenya

Annual average yields (2007-2017)



- Maize yields similar in conventional and organic.
- Potatoes and green beans yields are lower in organic (→ pest and diseases!)

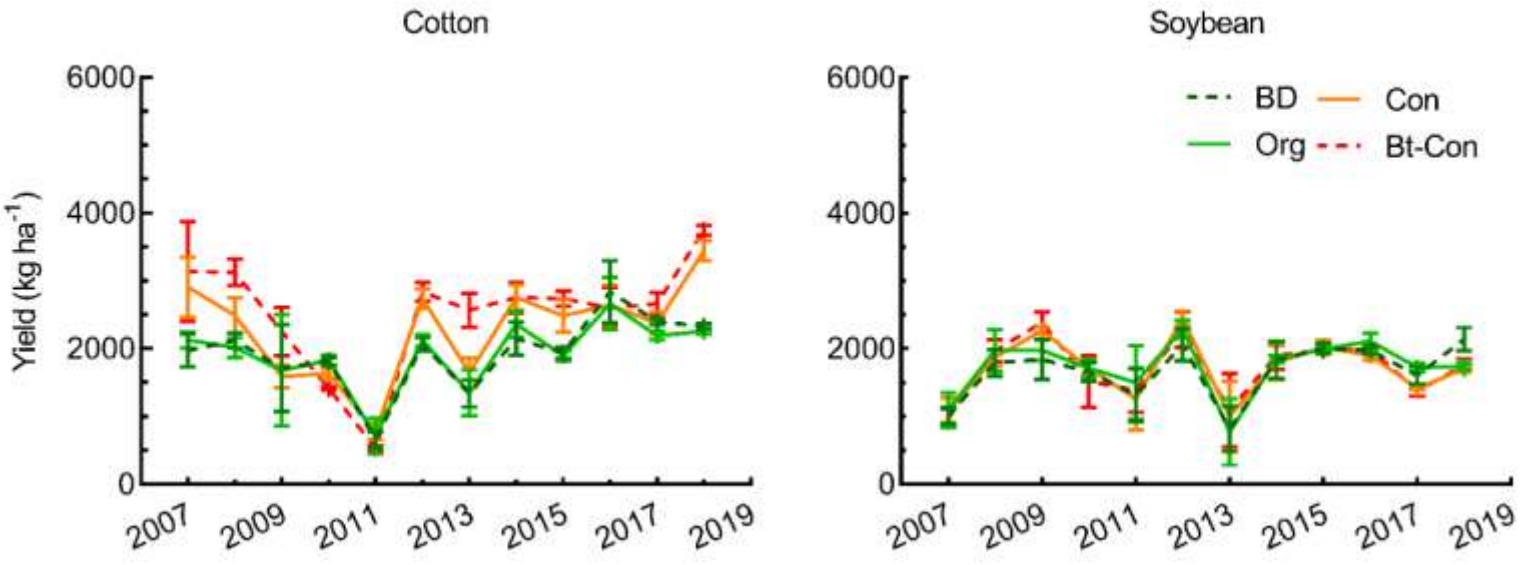
Source: Adamtey et al. (2016) & Bautze et al. (unpublished)

Crop Yield development

- Variation over years

India

Crop yield development (2007-2019)



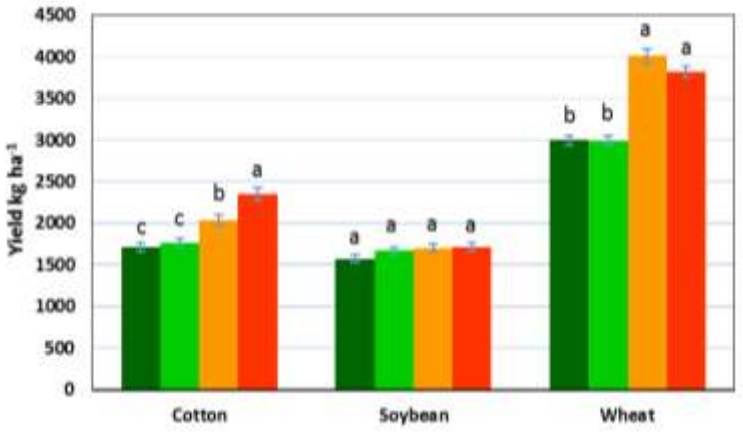
- Yields vary substantially over the years
- Long-term experiments reflect the more realistic picture

Productivity & Profitability

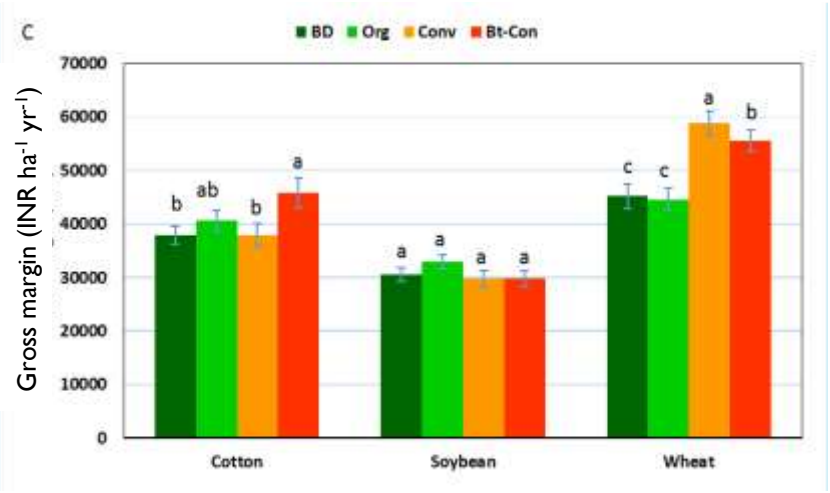
- Crop yields and economic differences

India

Annual average yields (2008-2014)



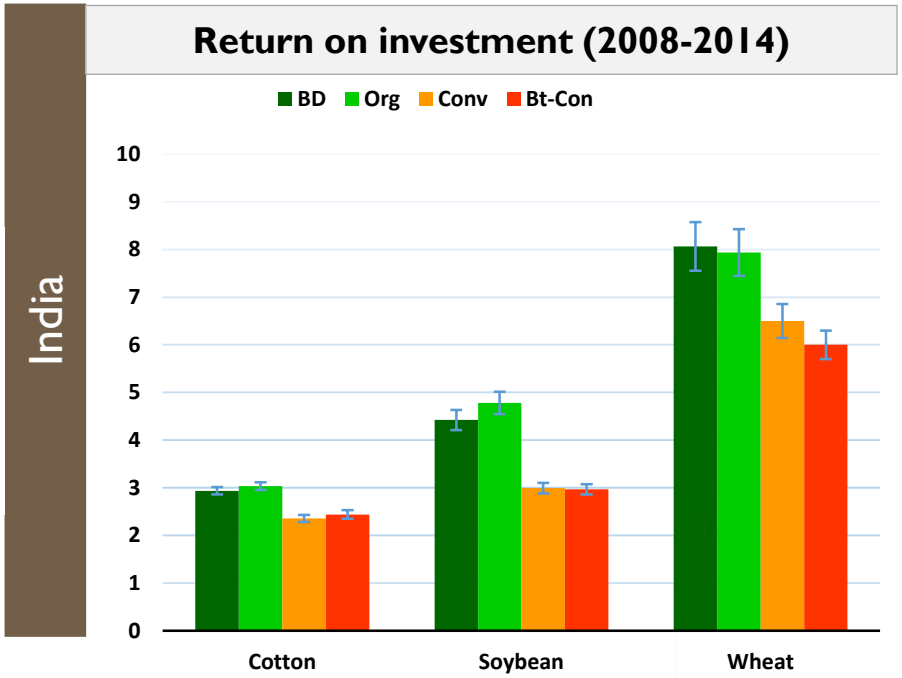
Annual average gross margin (2008-2014)



- Cotton and wheat yields lower in organic, soybean yields equal
- Organic production systems can have equal or higher gross margins

Return on Investment

- Return on investment



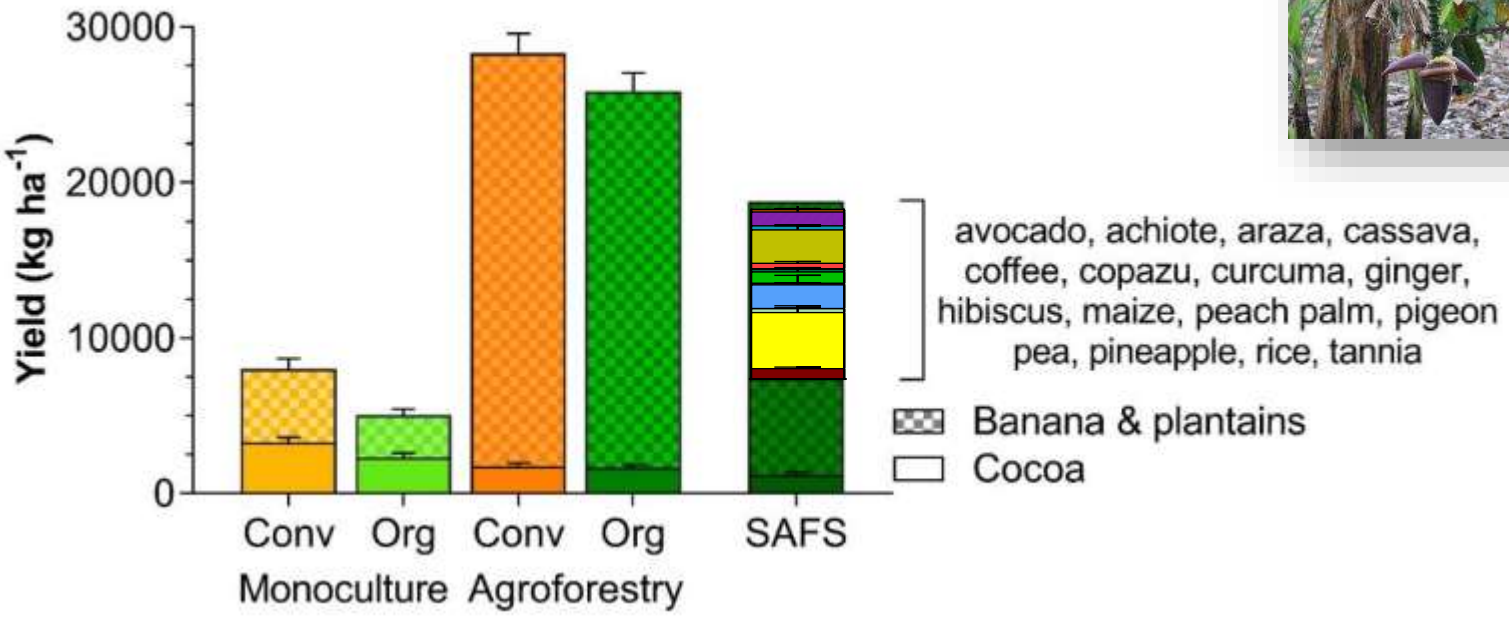
- Organic production systems have higher Return on Investment
- Organic production is highly relevant for resource poor farmer

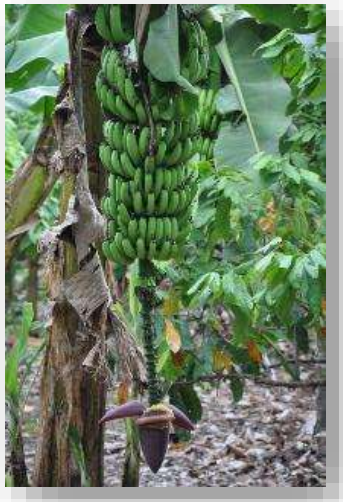
Yields

- Crop yields

Bolivia

Cumulative crop yields (2010-2017)





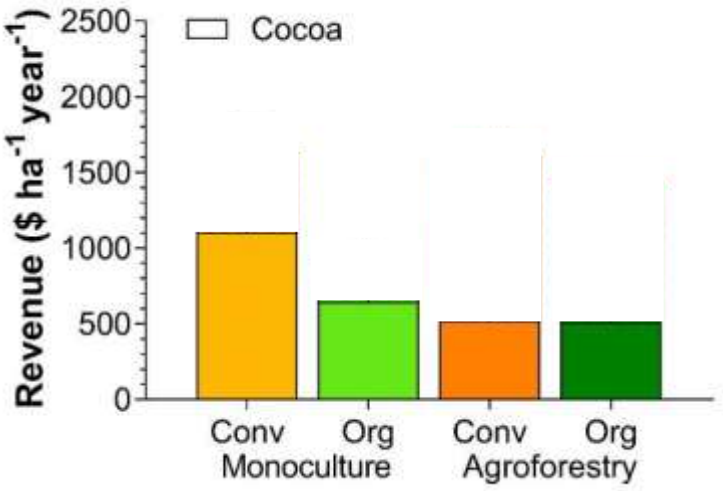
- Higher cumulative yields in agroforestry systems.
- Organic monocrop systems with lower yield compared to conventional monocrops.

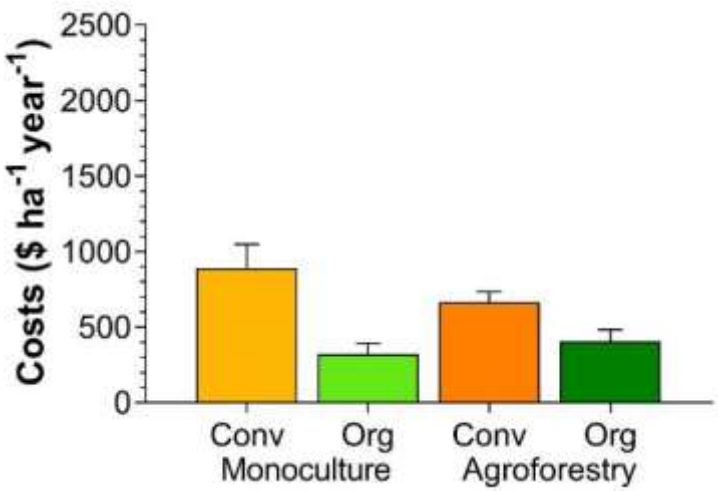
Profitability & Profitability

- Revenues and costs of a young plantation (initial 5 years)

Bolivia

Revenues (in US$)	**Costs, without labor** (in US$)





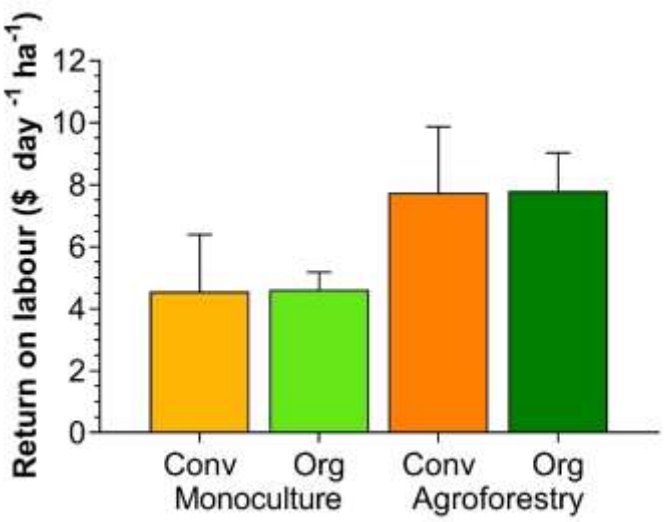
- Revenues from cacao higher in monoculture comparted to agroforestry.
- Revenues from by-crops in agroforestry overcompensate lower cocoa yields.
- Costs lower in agroforestry and organic systems: less fertilizer, less/no herbicides.

Return on Labor

- Average of 5 years in young plantation (2010-2014)

Bolivia

Return on labor (US$ per day)



- Higher Return on labor in Agroforestry Systems
- Exceeding national poverty line of 1.90 US$ day^{-1} (World Bank)
- But below minimum salary in Bolivia (8.7 $ day^{-1})

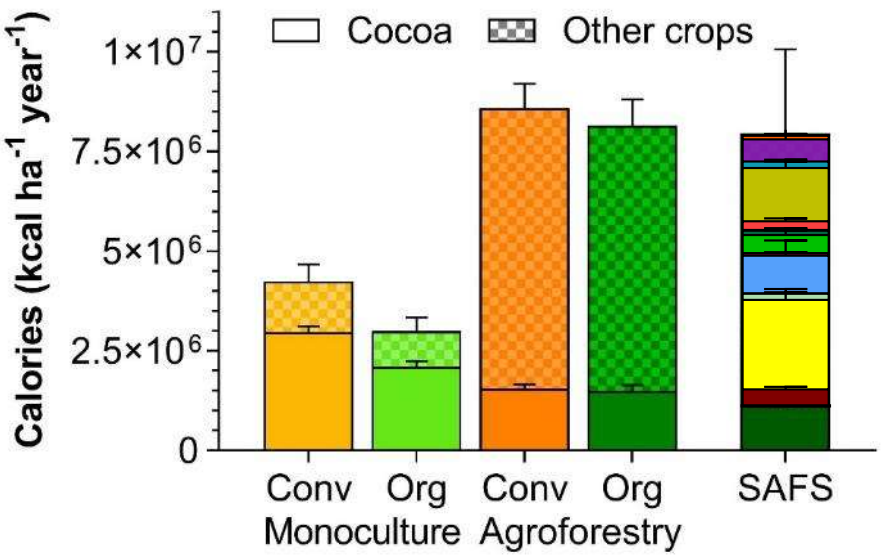
Source: Armengot et al. (2016)

Nutrition potential

- Calories of yields of the different crops

Bolivia

Average calories per yields (2010-2017)



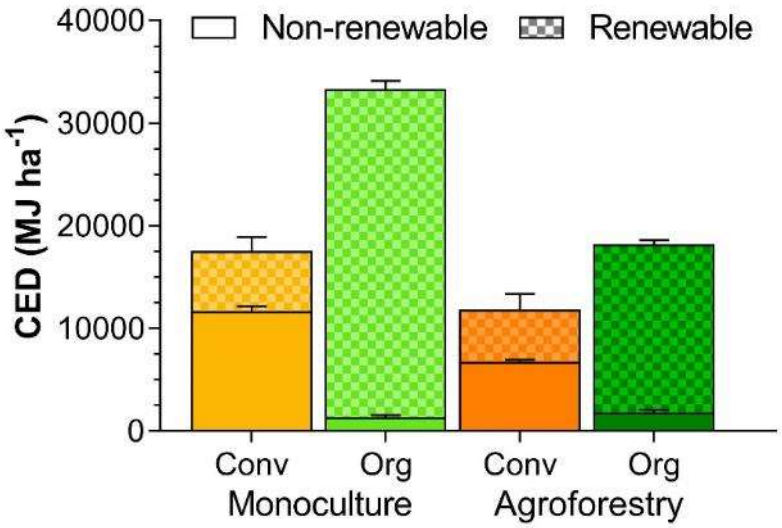
- Higher calorie production in agroforestry systems
- More diverse nutrients in agroforestry systems

Resource use efficiency

- Renewable and non-renewable energy input

Bolivia

Average energy input (2010-1014)



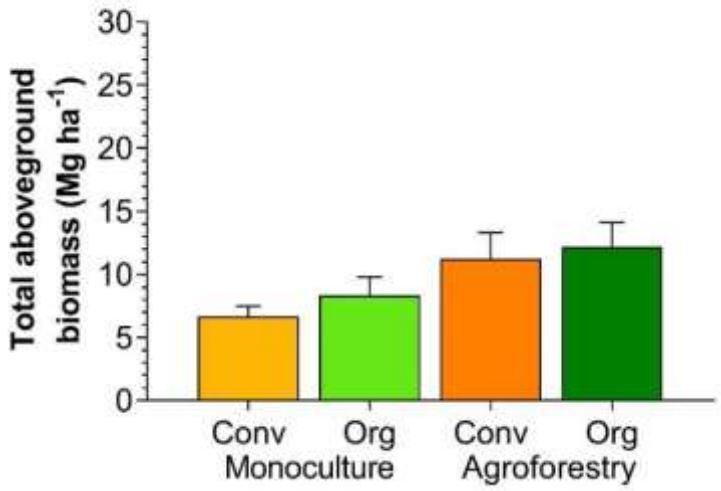
- Non-renewable energy inputs substantially higher in the conventional systems

Climate mitigation potential

- Above ground carbon (AGC)

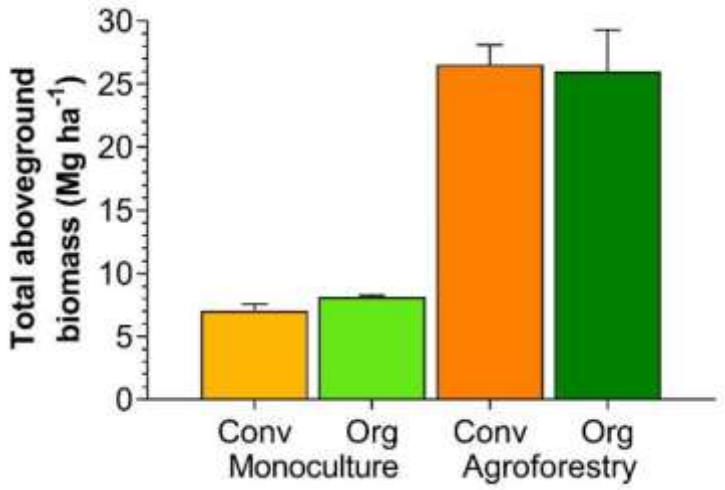
Bolivia

Above ground biomass 2011 (after 2 years)



Bolivia

Above ground biomass 2015 (after 6 years)



- Agroforestry systems has higher carbon mitigation potential then monoculture

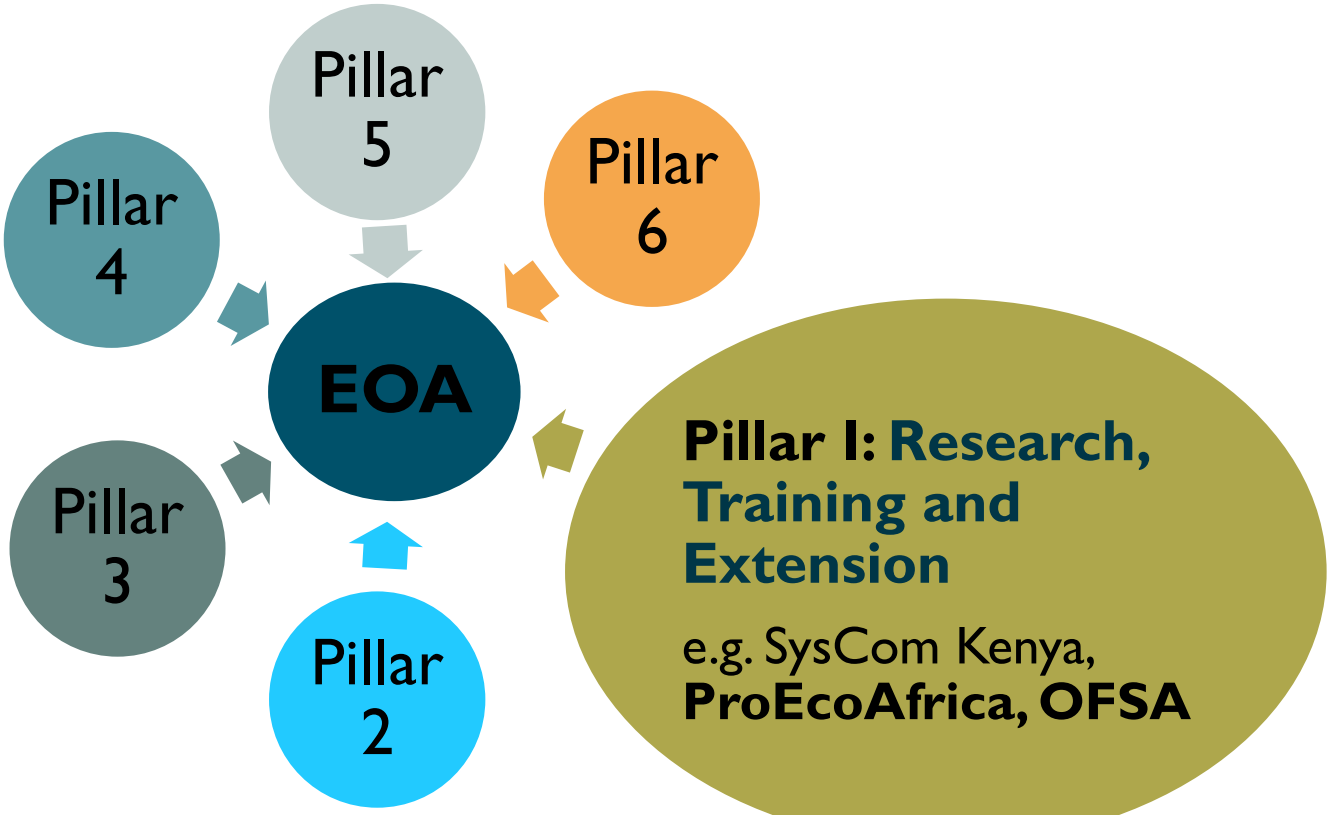
Source: Schneidewind et al. (2018)

ProEcoAfrica/OFSA

2011 High level Decision on Organic Agriculture (OA) – by African Union (AU) Heads of States and Government

(AU Council Decision on Organic - at the 18th Ordinary Session, 24-28 January 2011, EX.CL/Dec.621 (XVIII)

- Mainstreaming OA into national agricultural systems by 2025
- Ecological Organic Agriculture (EOA) - initiative in response



ProEcoAfrica/OFSA - key research questions

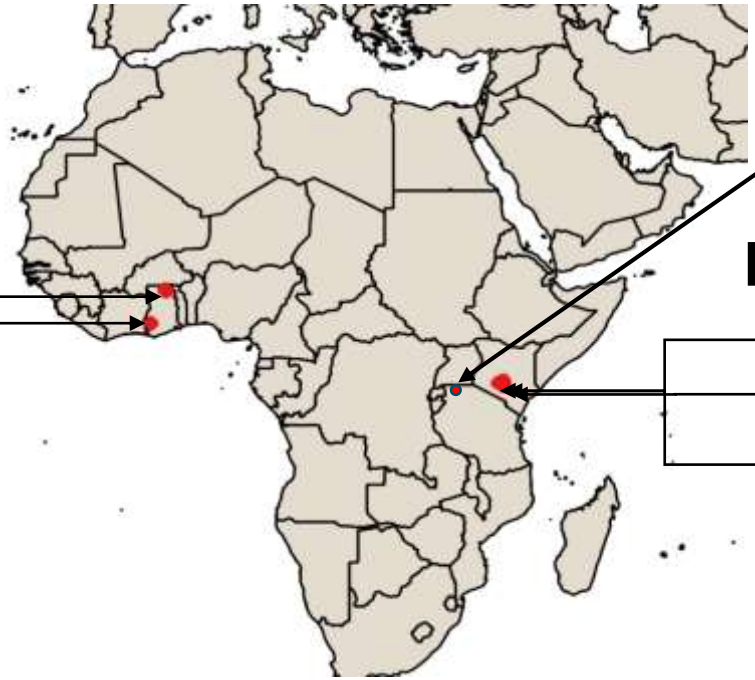
- **For** organic and conventional **smallholder farms, with respect to:**
  - Productivity,
  - Profitability,
  - Sustainability,

  1. What are the **determining factors**?
  2. What are the key **differences,** if any?
  3. How can farmers **improve** performance?

Comparions based on farmers' practices: >2,000 farms since 2014

Case study locations and reasons for selection

- Existing comparable organic and conventional farms
- Organic farms (≥3 years under organic)
  - Certified and non-certified
  - 6 entry organic crops from 7 sites



Uganda
"Coffee" Case Study Sites

Ghana
"Onion" Case Study

"Cocoa" Case Study

Kenya
"Macadamia" Case Study

"Mango" Case Study

"Cabbage" Case Study

Ghana

Ashanti

- Cocoa – **certified**
- Humid zone
- 399 farmers (44% F)

North-eastern Region

- Onion – non-certified
- Semi-arid zone
- 398 farmers (23% F)

Uganda

Kasese and Sheema (OFSA)

- Coffee – **certified** Fair Trade, Fair Trade Organic
- Humid zone
- 362 farmers (50.2% F)

Kenya

Kirinyaga

- Macadamia – **certified**
- Humid zone
- 282 farmers (23% F)

Machakos

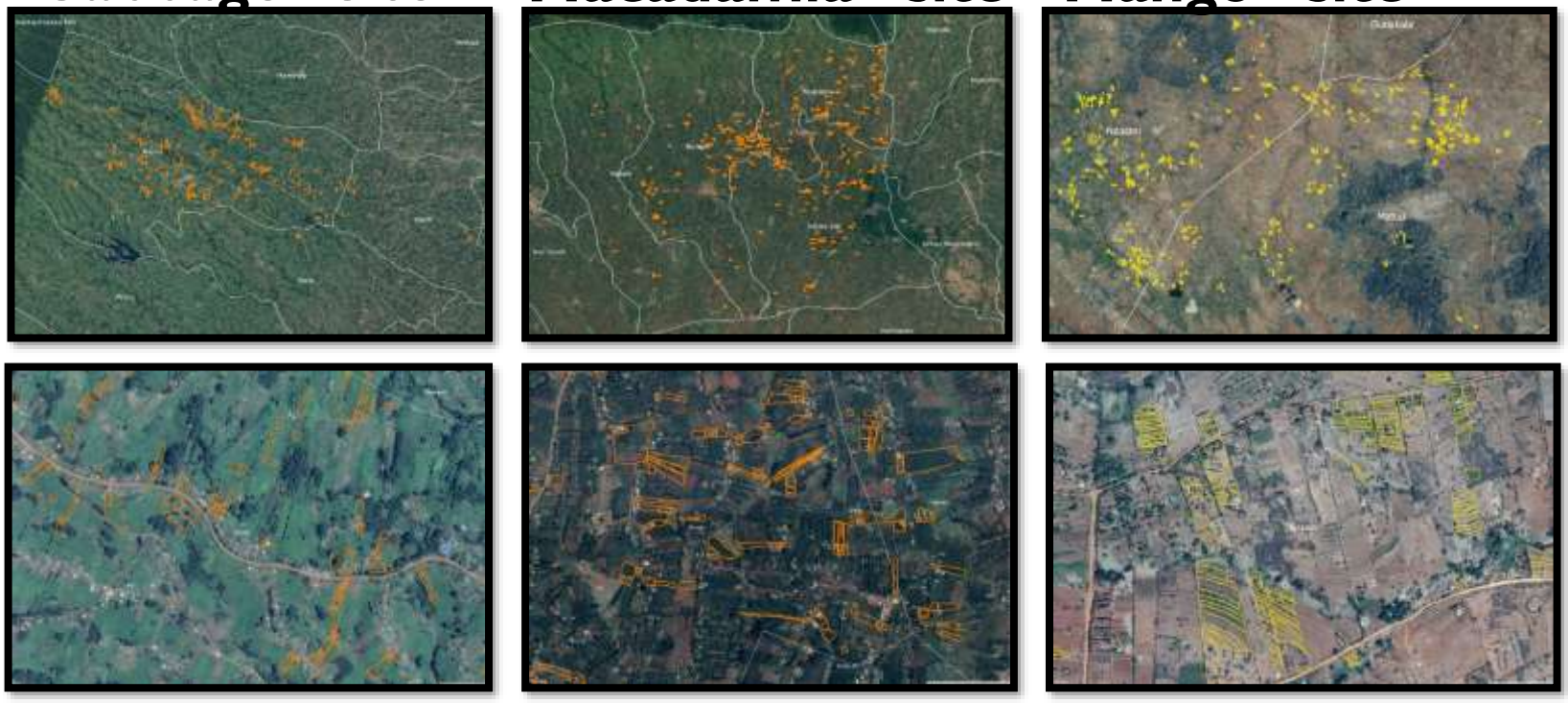
- Mango – non-certified
- Semi-arid zone
- 296 farmers (50% F)

Muranga

- Cabbage – non-certified, Humid zone, 294 farmers (62% F)

Farm and field area measurements – GPS

"Cabbage" site "Macadamia" site "Mango" site



Average farm sizes:

- Ghana – 2.83 to 3.22 ha
- Kenya – 0.48 to 1.05 ha

Modelling of productivity & profitability – ProEcoAfrica (whole farm)

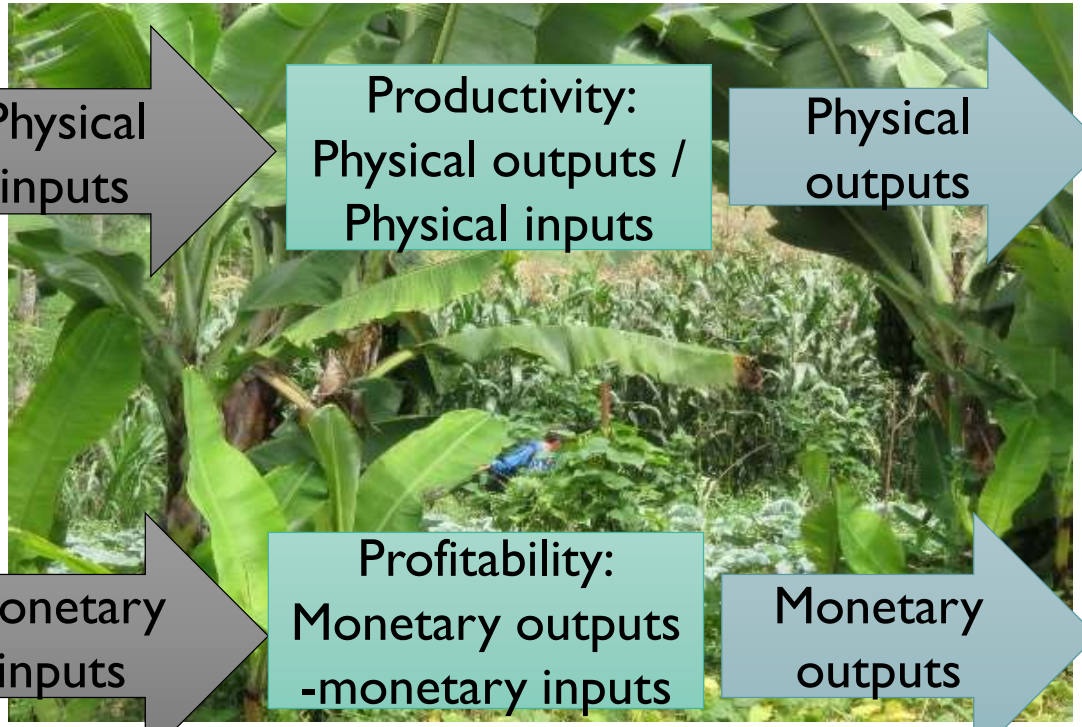
Seedlings
Fertiliser
Compost
Water
Pesticides
Labour

Physical inputs

Productivity: Physical outputs / Physical inputs

Physical outputs

Kgs, Litres, etc



Costs

Monetary inputs

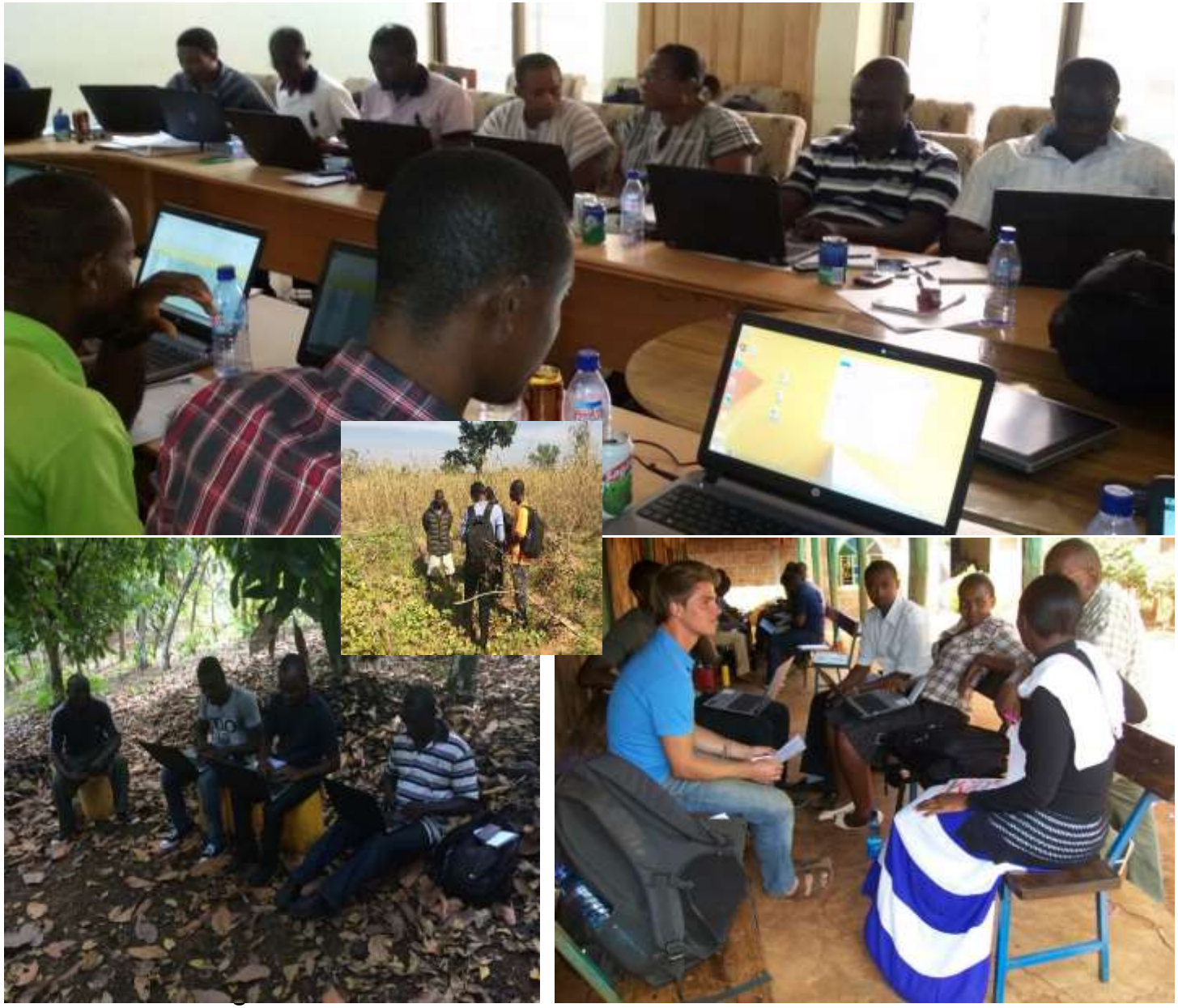
Profitability: Monetary outputs -monetary inputs

Monetary outputs

Revenues

ProEcoAfrica data collected for 5 seasons (2014-17)

OFSA data collected once per site



Farming systems re-classification taking into account the actual farm management

Initial farm categorisation (for farm sampling)

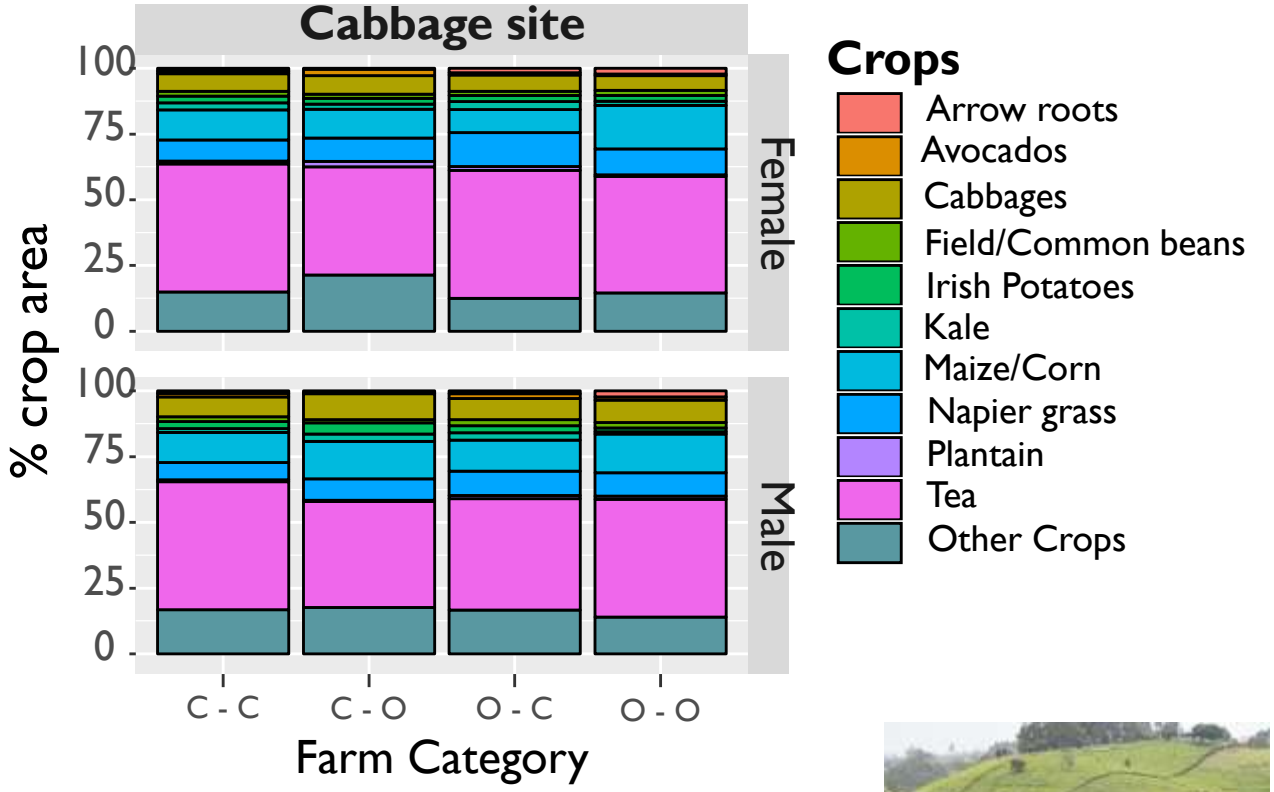
Reported use of prohibited Input(s) during study period	**Organic**	**Non-organic / Conventional**
No	**O-O** Recruited as organic. No prohibited inputs reported	**C-O** Recruited as conventional No prohibited inputs reported
Yes	**O-C** Recruited as organic **Used** inputs prohibited in organic	**C-C** Recruited as conventional **Used** inputs prohibited in organic

Some of the reasons for practicing organic

- Health, profitability, market access, conviction of benefits

Top 10 crops based on land area occupied in 'Cabbage' Case Study (Kenya)

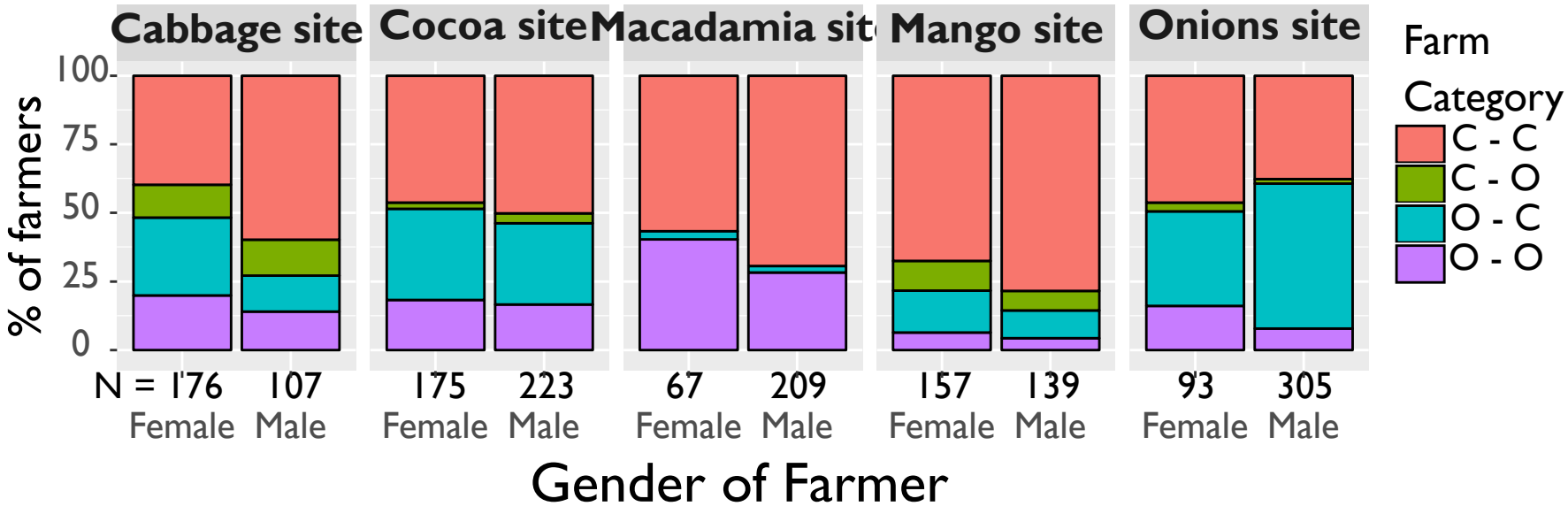
- Tea dominant.
- No major differences, but C-C farmers seemed to have > land under tea.
- Farm cropping characteristics are quite comparable.



FiBL www.fibl.org

Schader et al., in preparation; preliminary results, do not cite

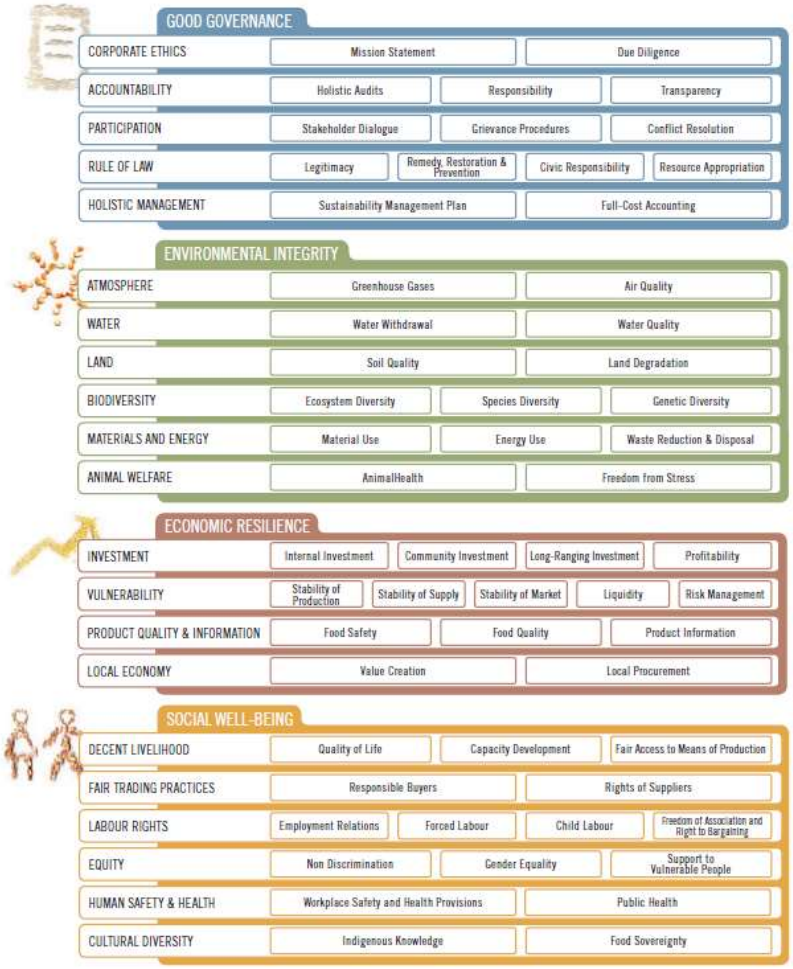
Females tended to constitute a > % of the O-Os



- **Site differences**
  - O-O % highest in Macadamia site - both females and males.
- **Farming system differences**
  - Females constituted a > % of the O-O farmers in all sites.
  - Shift in practices: C-O and O-C.

Schader et al., in preparation; preliminary results, do not cite

Guidelines for Sustainability of Agriculture and Food Systems (SAFA)

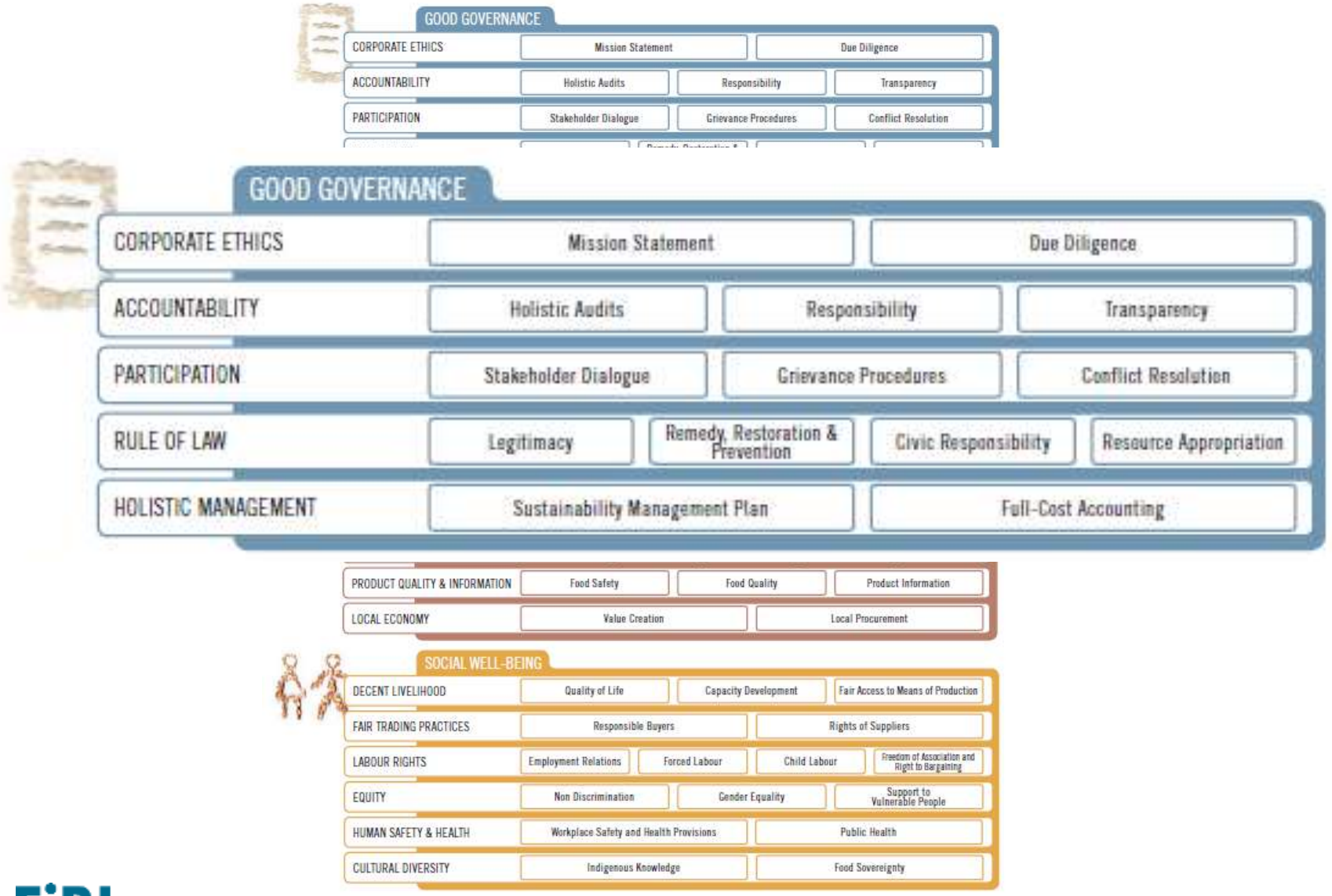


- 4 Dimensions
- 21 Themes
- 58 Sub-themes with sustainability objectives

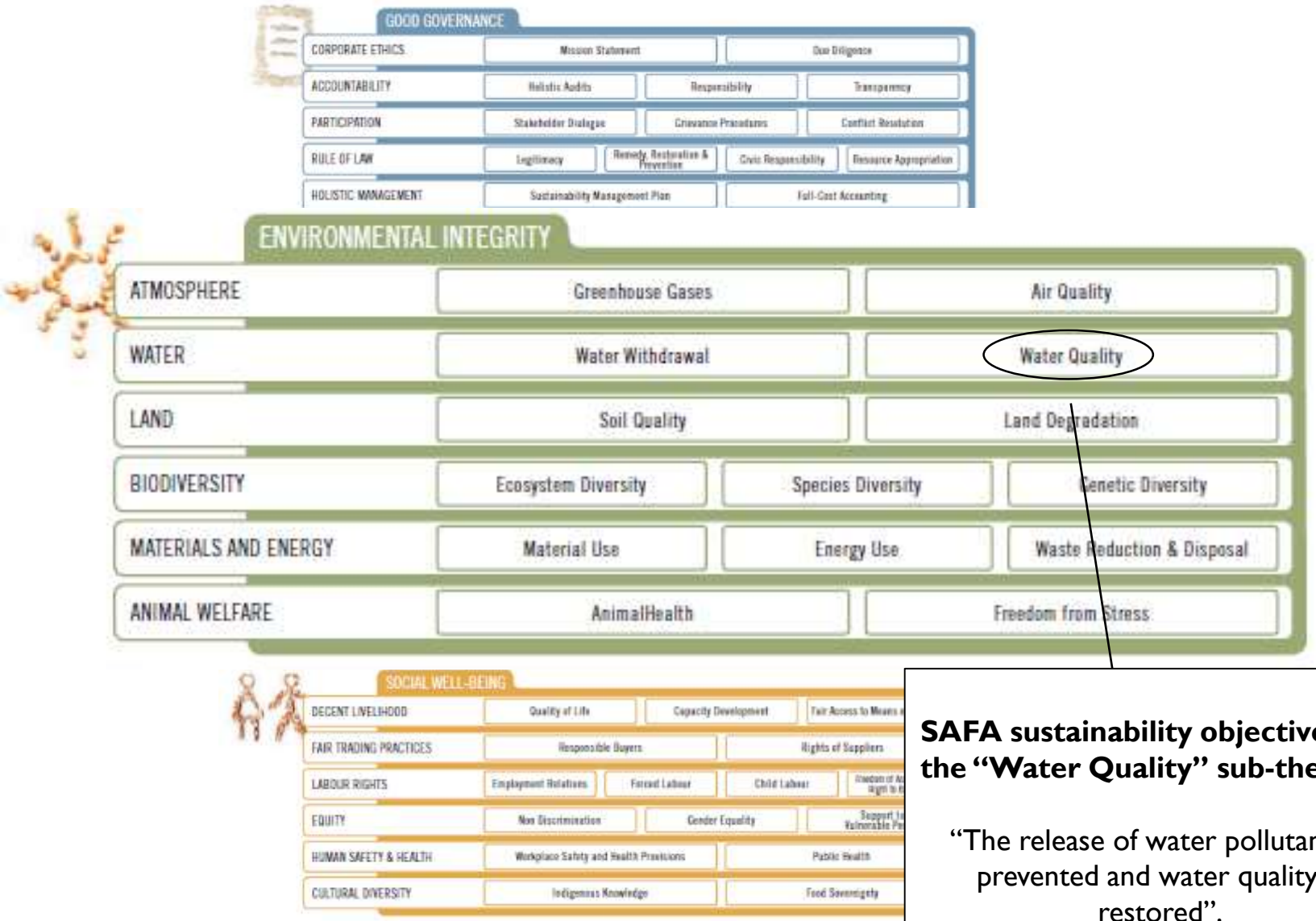
SAFA
SUSTAINABILITY ASSESSMENT OF FOOD AND AGRICULTURE SYSTEMS

Food and Agriculture Organization of the United Nations

Good Governance



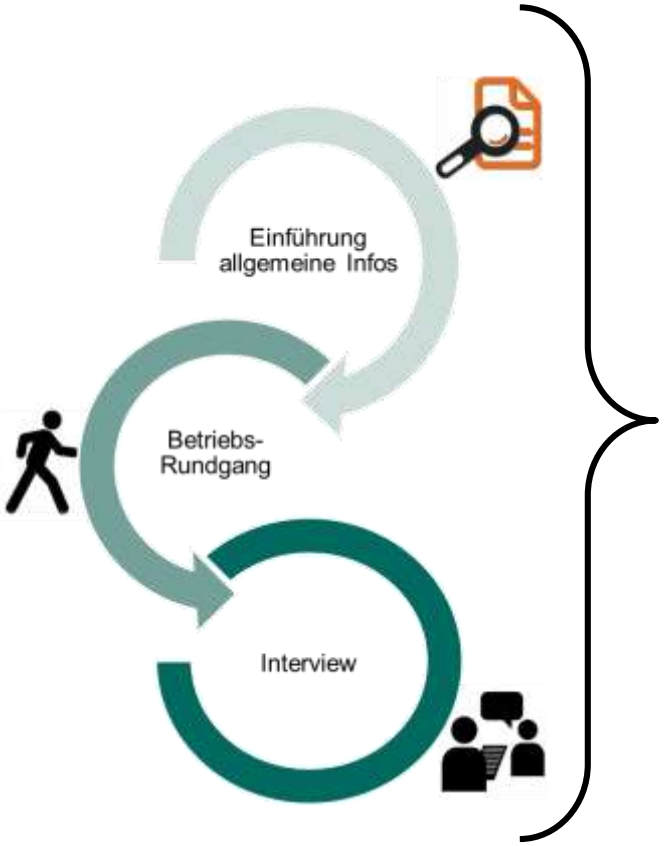
Environmental integrity

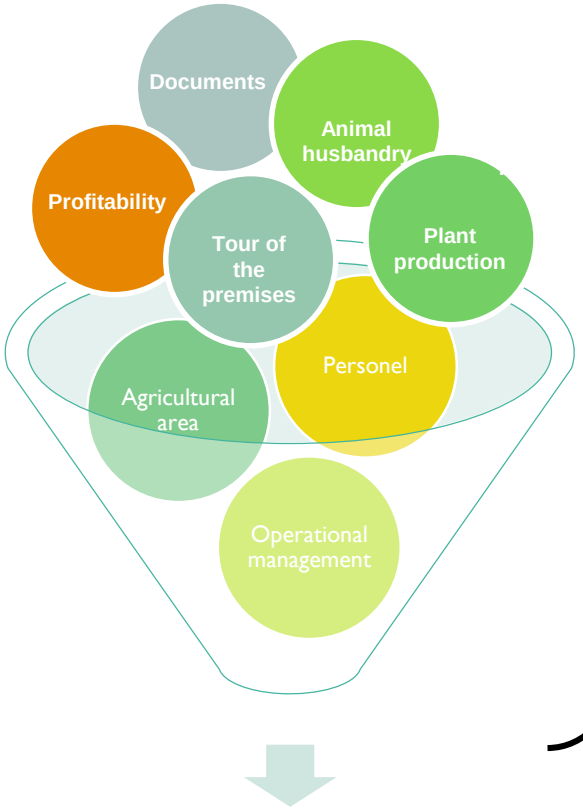


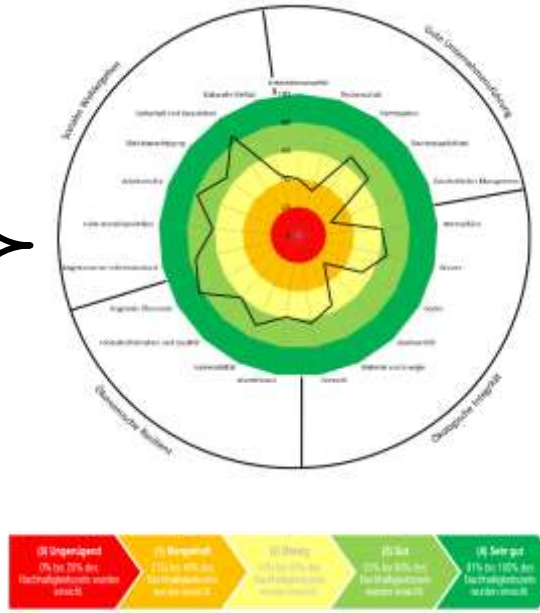
SAFA sustainability objective fot the "Water Quality" sub-theme:

"The release of water pollutants is prevented and water quality is restored".

Process flow SMART Farm Assessment







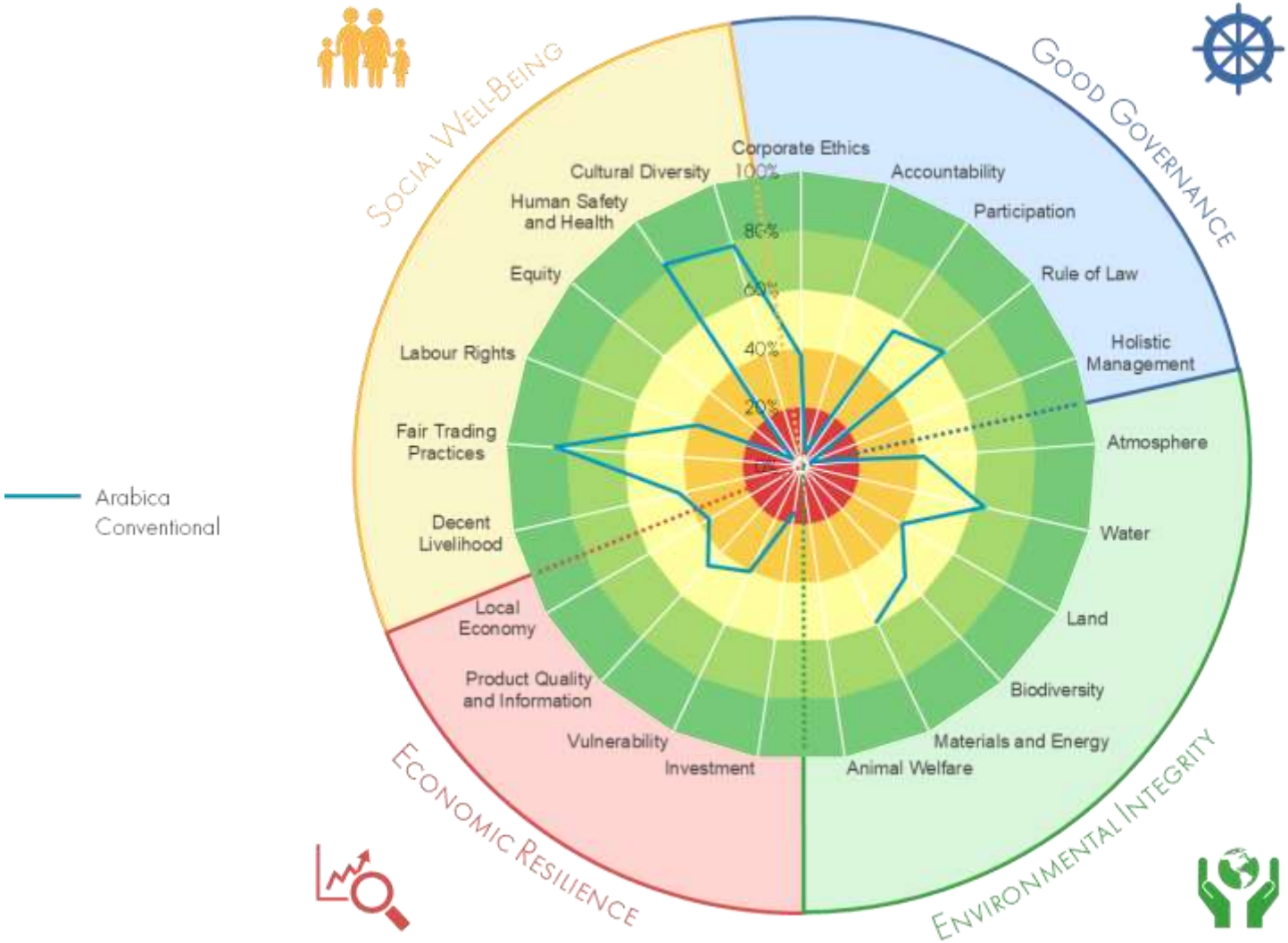
Farm Survey
(appr. 2-3 h)

Analysis

Evaluation

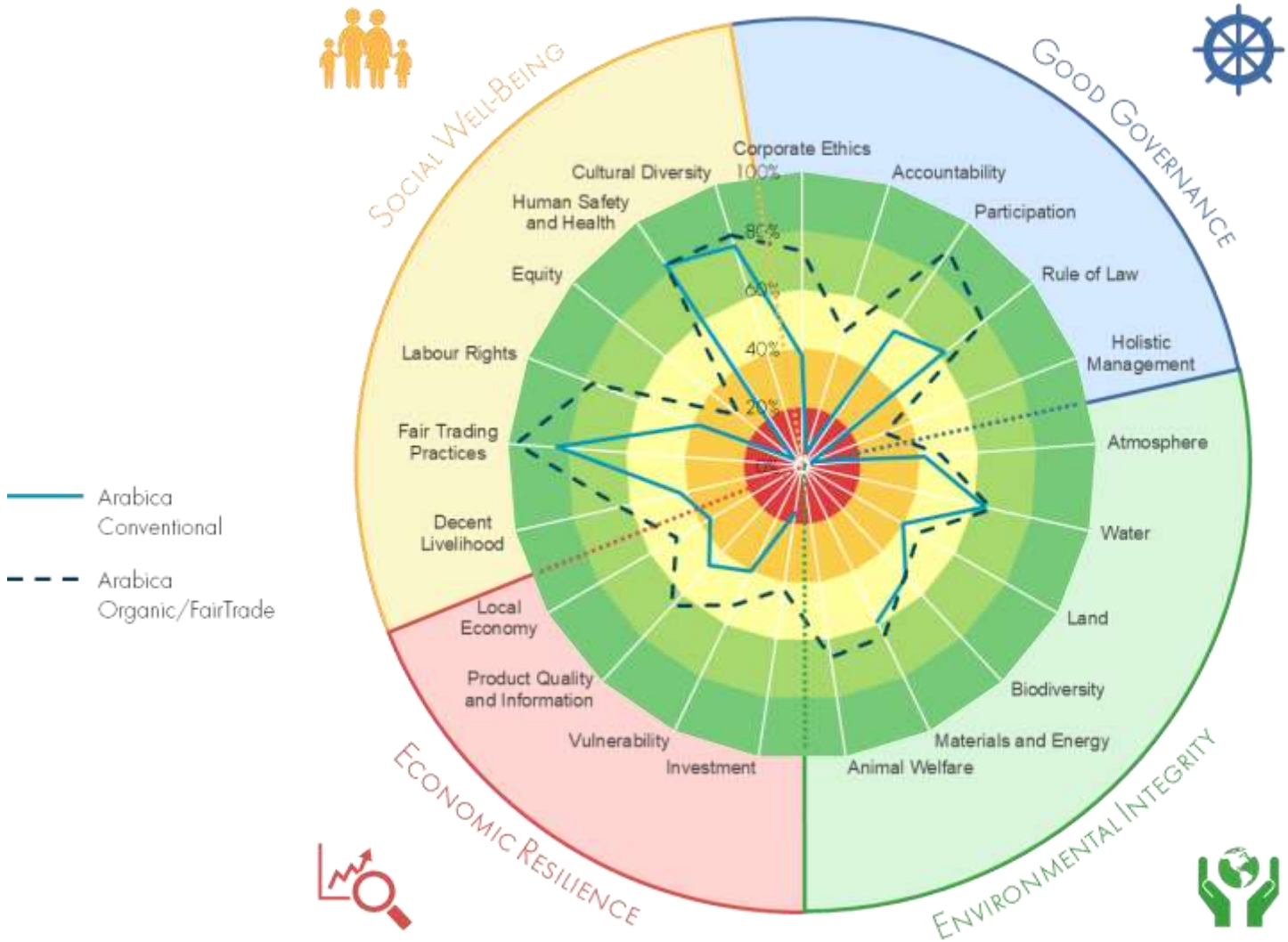
On farm data collection

Performance of Arabica coffee farms in Uganda with respect to SAFA sustainability themes



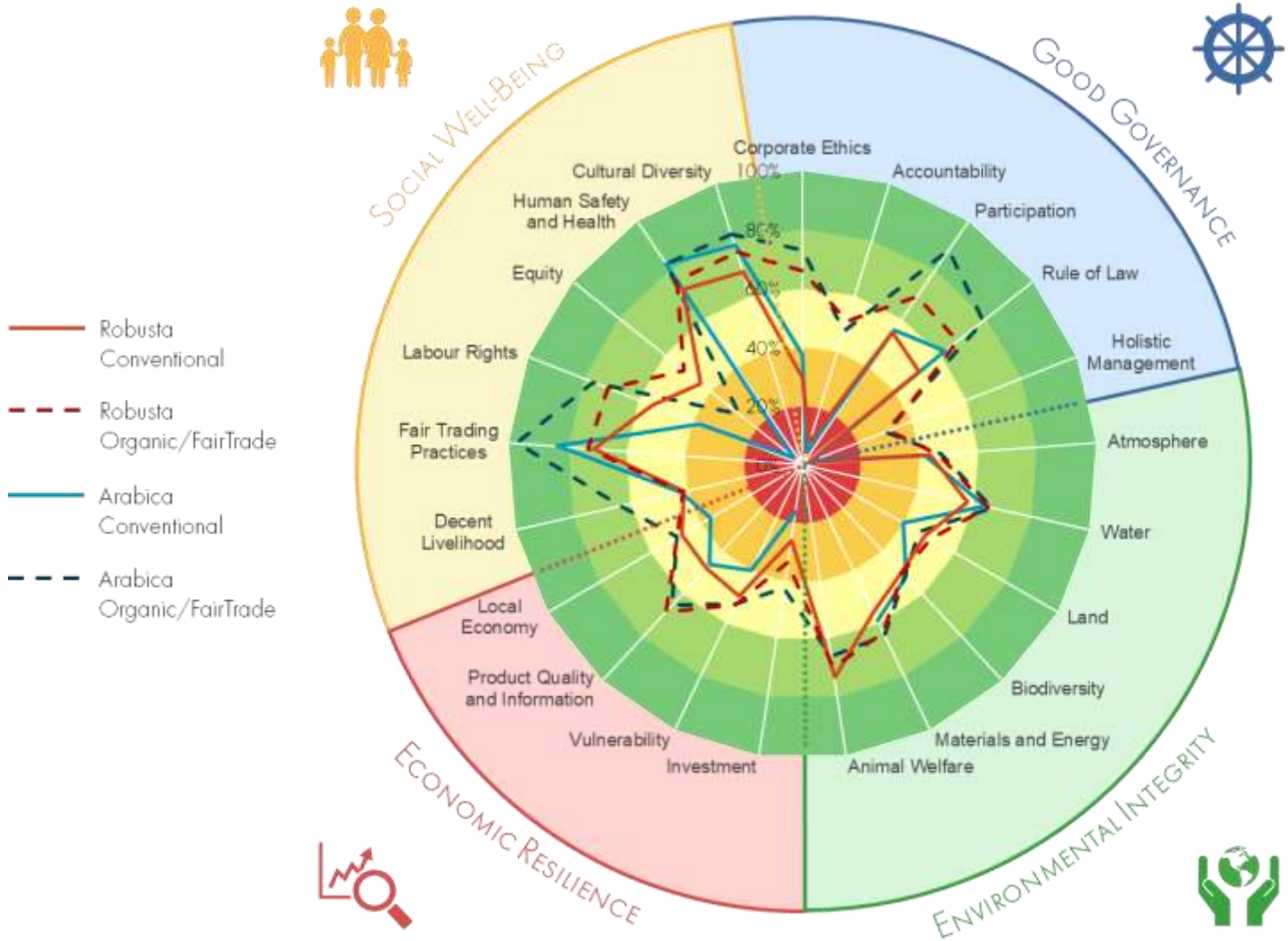
Source: Ssebunya et al 2019

Performance of Arabica coffee farms in Uganda with respect to SAFA sustainability themes



Source: Ssebunya et al 2019

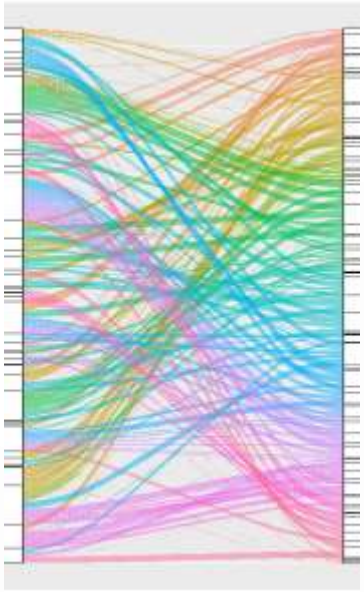
Performance of Arabica and Robusta coffee farms in Uganda with respect to SAFA sustainability themes

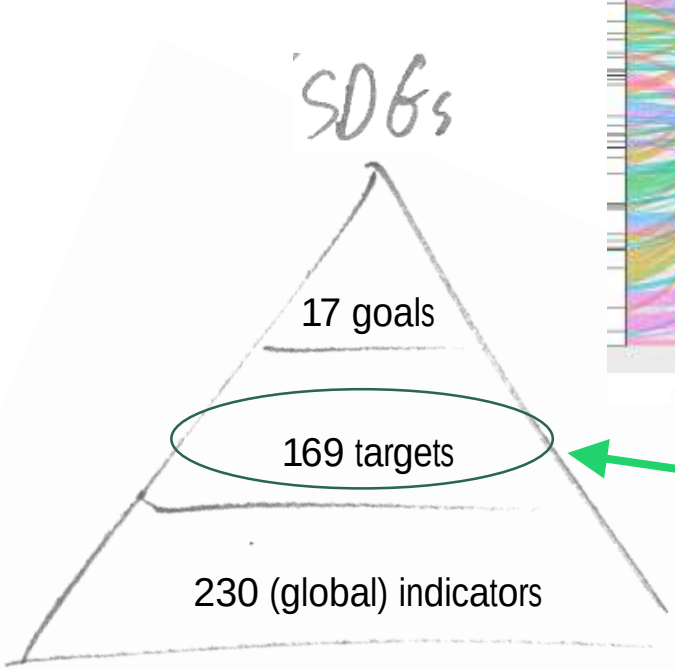


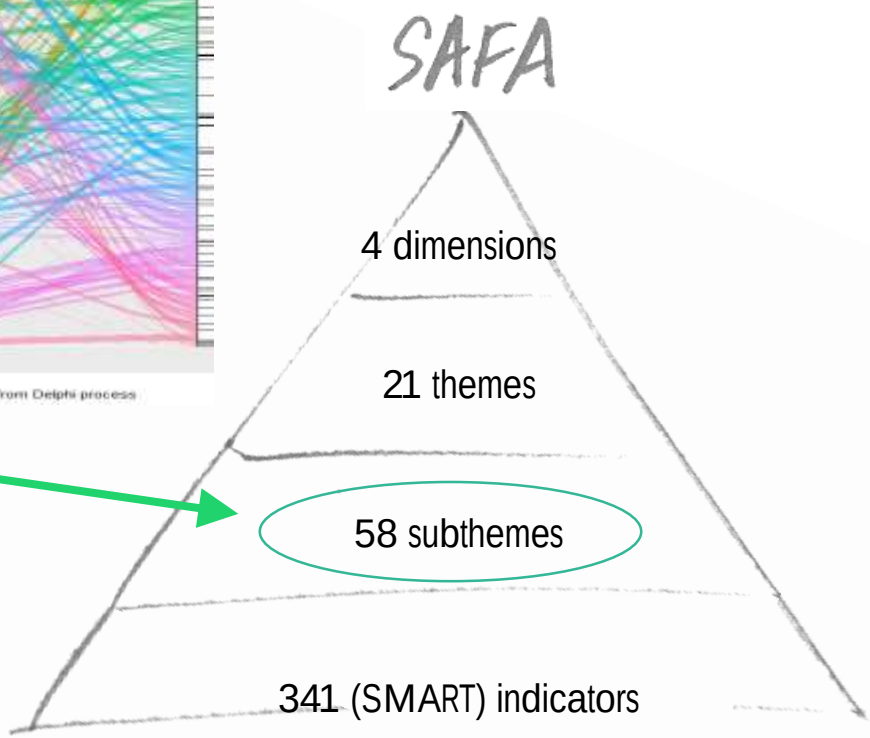
Source: Ssebunya et al 2019

Sustainable Development Goals (SDGs)

Linking SAFA and SMART to SDGs

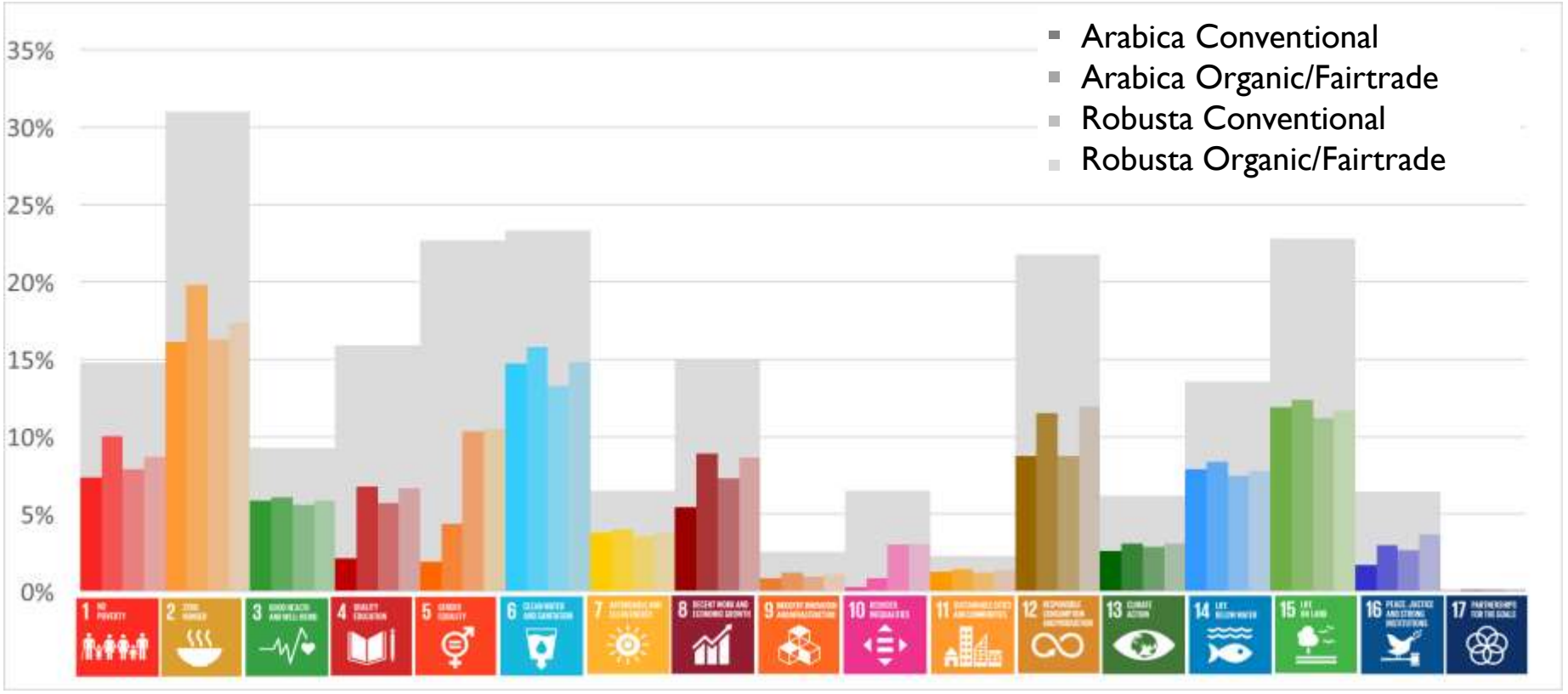






Comparison at these levels offers a manageable and informative degree of differentiation

Contribution of conventional and organic coffee farming systems in Uganda to the SDGs



FiBL

www.fibl.org

Based on Ssebunya et al. 2019

Conclusions:

No silver bullet

Organic agriculture has large potential to contribute to sustainable development

- Soil fertility
- Biodiversity Conservation
- Productivity & Profitability

For full exploitation major efforts are needed to tackle:

- Agronomic/ technological challenges (lack of input, pest management)
- Capacity development for farmers (technical know how)
- Institutional/governance challenges (markets, agri-business)
- Policy challenges

Sources


Agriculture, Ecosystems and Environment

journal homepage:

Productivity, profitability and partial nutrient balance in maize-based conventional and organic farming systems in Kenya


CARBON STOCKS, LITTERFALL AND PRUNING RESIDUES IN MONOCULTURE AND AGROFORESTRY CACAO PRODUCTION SYSTEMS

By ULF SCHNEIDEWIND†§, WIEBKE NIETHER†, LAURA ARMENGOT‡, MONIK

† Departmen
Göttingen, Germ

Expl Agric.: page 1 of 24 © Cambridge University Press 2016
doi:10.1017/S0014479716000417


Yield and Economic Performance of Organic and Conventional Cotton-Based Farming Systems – Results from a Field Trial in India

Dionys Forster, Christian Andres, Rajeev Verma, Christine Zundel, Monika M. Messmer, Paul Mäder

Abstract

Introduction


Science of the Total Environment

Below- and aboveground production in cocoa monocultures and agroforestry systems

Wiebke Niether, Ulf Schneidewind, Michael Fiche, Monika Schneider, Laura Armengot

HIGHLIGHTS

GRAPHICAL ABSTRACT

ARTICLE INFO

COCOA AND TOTAL SYSTEM YIELDS OF ORGANIC AND CONVENTIONAL AGROFORESTRY VS. MONOCULTURE SYSTEMS IN A LONG-TERM FIELD TRIAL IN BOLIVIA

By M. SCHNEIDER, P. AMURRI

† Department of Internatio
Ackerstrasse 113, Postfac
/ Tejada Sorza
ille 27, Cota C
Foundatio

Ecología en Bolivia 52(2): 100-115. Septiembre 2017. ISSN 1605-2528.

Selección de diferentes sistemas de producción de cacao (*Theobroma cacao*, Malvaceae) por aves en Alto Beni, Bolivia - una prueba de cafetería en el campo

Selection of different cacao (*Theobroma cacao*, Malvaceae) production systems by birds in Alto Beni, Bolivia - a cafeteria experiment in the field

Kazuya Naoki[1]*, M. Isabel Gómez[2] & Monika Schneider[3]

[1]Centro de Análisis Espacial, Instituto de Ecología, Universidad Mayor de San Andrés, Calle 27 Cota Cota, La Paz, Bolivia. *Autor de correspondencia: knaoki@fcpn.edu.bo
[2]Colección Boliviana de Fauna - Museo Nacional de Historia Natural, Calle 26 Cota Cota, La Paz, Bolivia
[3]Instituto de Investigaciones de Agricultura Orgánica (FiBL), Ackerstrasse, CH-5070 Frick, Suiza

Resumen

El cacao (*Theobroma cacao*, Malvaceae) es una especie nativa de Sudamérica, y se considera
de biodiversidad. Se estudió
o y barbecho, a través de una
ificadas por medio del conteo
visitas de 43 especies de aves
uencia de visitas de las aves
tructura vegetal y la diversidad
orestal sucesional (SAFS), los
46 para el número de especies,
ltivos se registró la mitad del
n los cultivos convencionales
la frecuencia observada en las
posición de aves entre el SAFS
getal diversa, alberga recursos
s agroforestales complejos de

producción agrícola, Selección

th America, and its plantation
liversity. We studied the birds'
a cafeteria experiment in Alto
during the dry season. During
the study we recorded 239 visits of 43 bird species belonging to 18 families. The number of species and the frequency of birds' visits were positively related to the complexity of vegetation structure and tree diversity, decreasing from fallow, successional agroforestry system (SAFS), agroforestry systems to monoculture plantations (1 = - 0.149 ± 0.046 for the number of species,

100

https://systems-comparison.fibl.org/

www.proecoafrica.net

www.fibl.org

FiBL

www.fibl

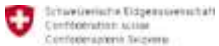
This research could only be realized without our donors and partners

Farmers and Field Staff in Bolivia, Ghana, India, Kenya, and Uganda









FiBL

www.fibl.org


Thank you very much for your attention!

EOA Pillars (https://eoai-africa.org/)

Research, Training and Extension

Value Chain and Market Development

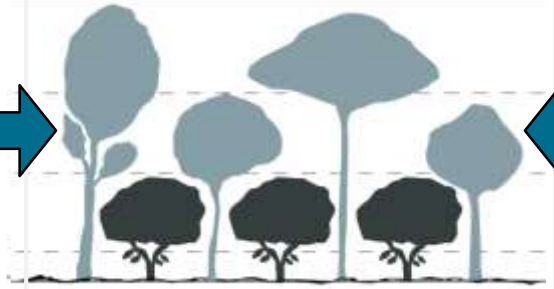
Networking and Partnerships

Policy and Programme Development

Institutional Capacity Development

Long-term Experiment (LTE)

Bolivia

Full sun system (Monoculture)	Agroforestry system	Successional agroforestry system
		
• Organic • Conventional	• Organic • Conventional	• Organic (no external input)

➢ Sara Ana, Bolivia 2008/09 → 8th year of grow of cacao in 2017