International Center for Tropical Agriculture
Since 1967 / Science to cultivate change

Climate-smart soil protection and rehabilitation in Ethiopia

December 2016, Addis Ababa, Ethiopia

An Notenbaert, Birthe Paul, Caroline Mwongera, Celine Birnholz, Deborah Bossio, Evan Girvetz, Jessica Koge, Juliet Braslow, Katherine Snyder, Rolf Sommer, Wendy Okolo, Biyensa Gurmessa and Mengistu Dessalegn

Outline

- **Introduction and objectives of the climate-smart soils (CSS) project**
- Climate-smartness evaluation
  - Farm Typology
  - Rapid Climate Smartness Assessment (Kalkulator)
  - Evaluation of Land Management Options (ELMO)
  - Attainable impact
- Recommendations

Objective of the Climate Smart Soils Project

- **Assessment of climate smartness of ongoing and potentially suitable alternative agricultural soil conservation practices, including:**
  - **analysis of farm-level cost-benefit and tradeoffs**
  - **evaluation of the overall CSA impact and scope**
  - **adoption and scaling potentials**

> **"Agriculture has to be part of the solution to climate change."**
>
> ***Patrick Verkooijen, The World Bank, 2012***

Climate smart agriculture

Triple-win goal – three pillars (FAO 2013):

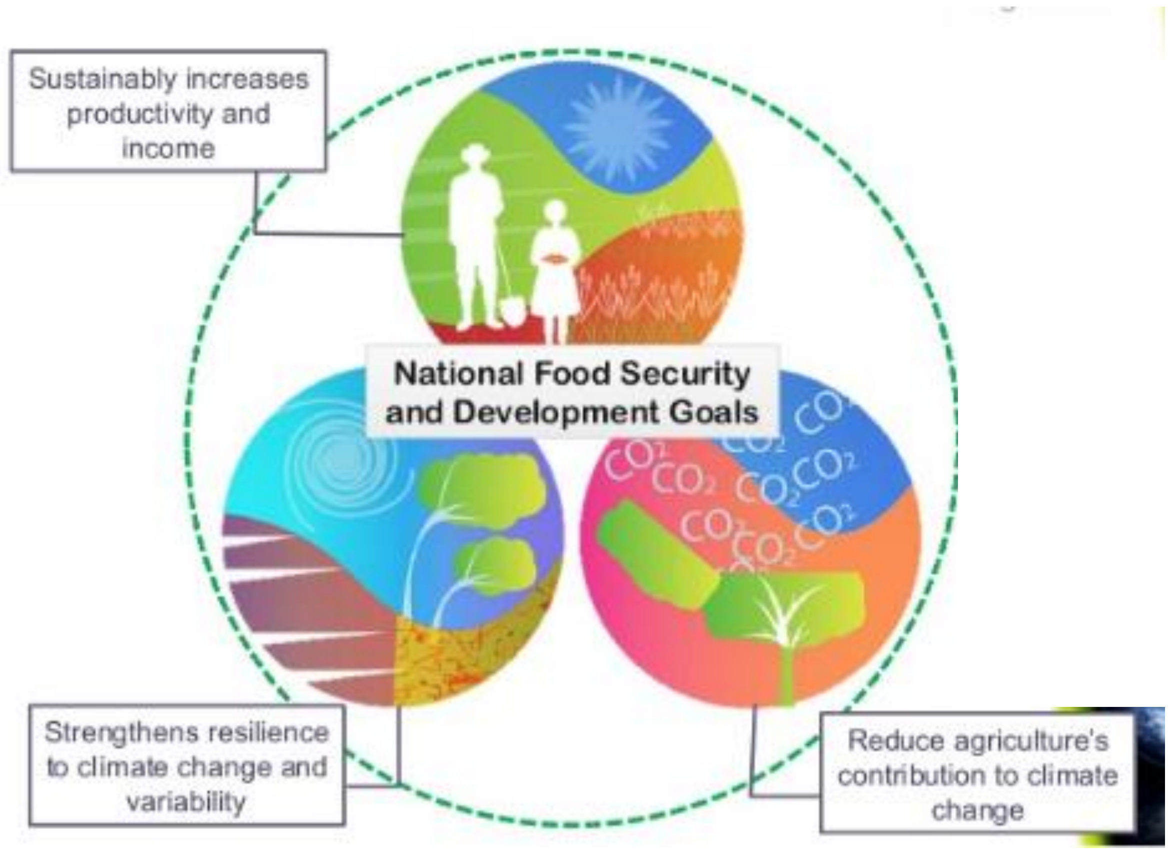
1. Sustainably increasing agricultural productivity and incomes;
2. Adapting and building resilience to climate change;
3. Climate change mitigation: reducing greenhouse gases emissions, where possible.

"To ensure a food-secure future, farming must become climate resilient."

Modelling of CSA indicators and trade-offs

Calories produced on farm/hectare

- Cash crops and meat not taken into account
- ‘Potential supply’ only



Soil nitrogen balances farm/hectare

- Simplified, non-holistic indicators

GHG emissions from agriculture per farm/hectare

- Soil C stock changes not included
- IPCC tier 1/2 overestimating for SSA

CSA rapid assessment - methodology

Stakeholder workshops → Farming system types → **Case study farmer interviews**

Stakeholder workshops ↓ Soil technology shortlist

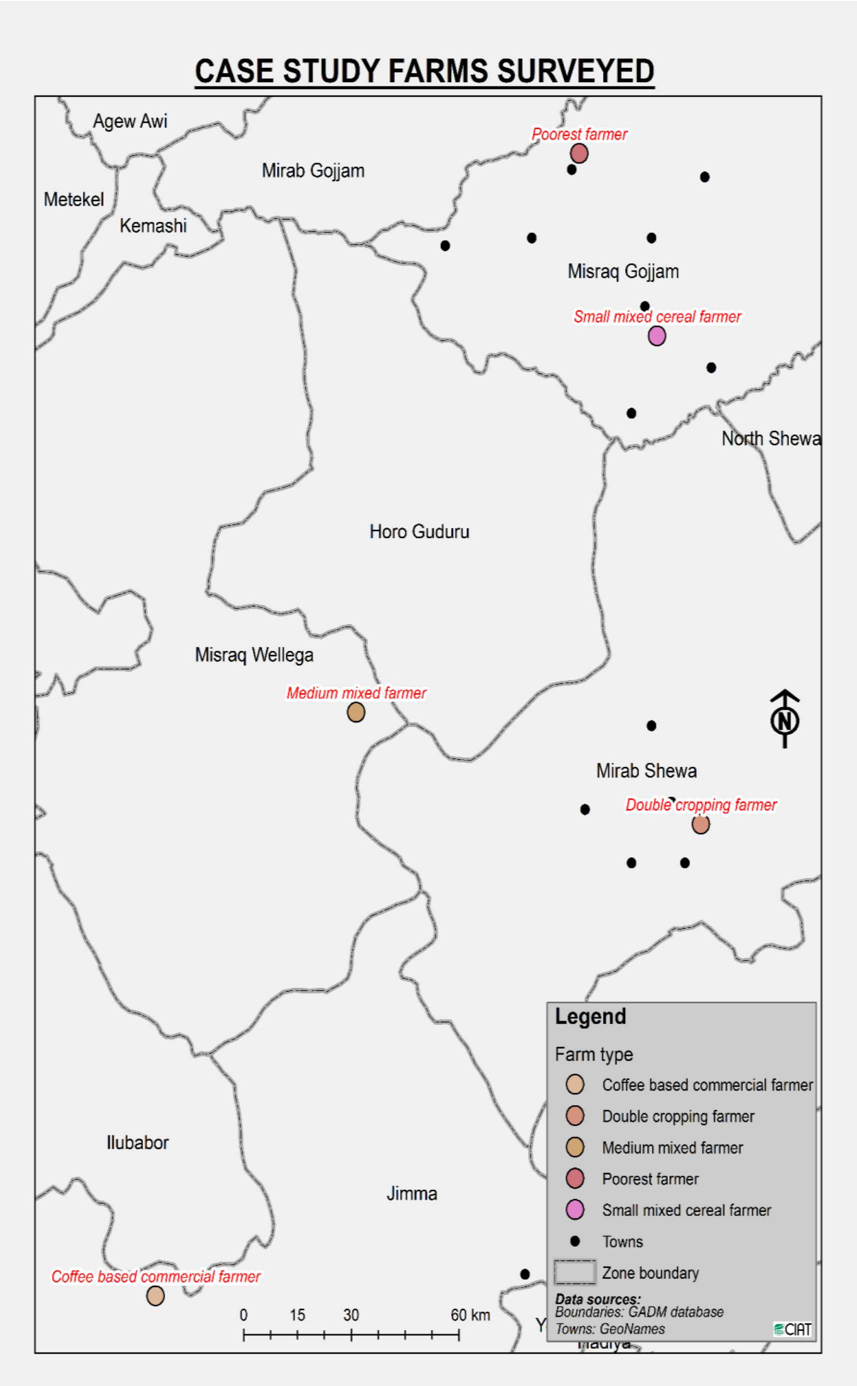
Case study farmer interviews ↓ Input data

Modelling CSA indicators for baselines and scenarios

Farming system types

Factors: intensification, production orientation, commercialization, agro-ecological potential and resource endowment

- Poorest farmer
- Small mixed cereal farmer
- Medium mixed cereal farmer
- Double cropping farmer
- Coffee based commercial farmer



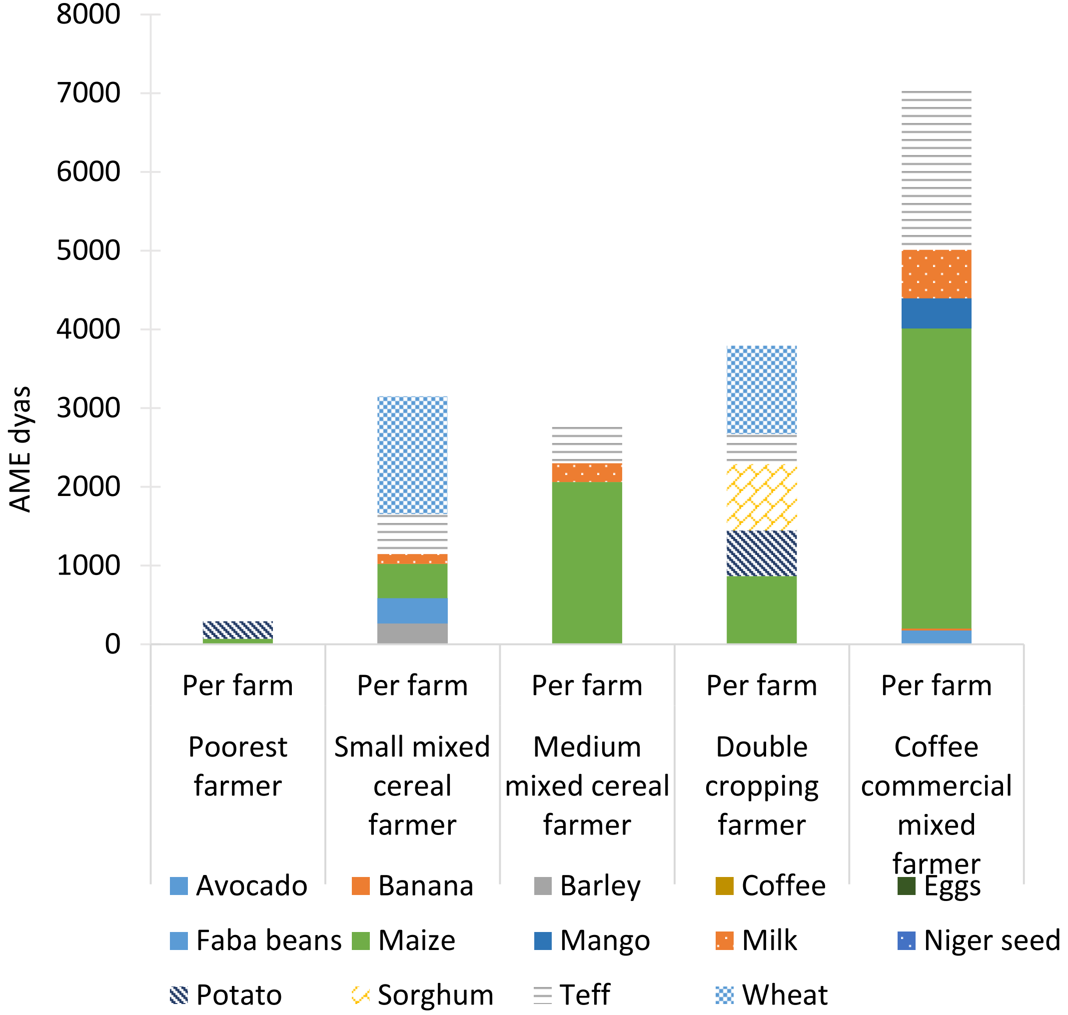
Shortlisted/tested soil technologies

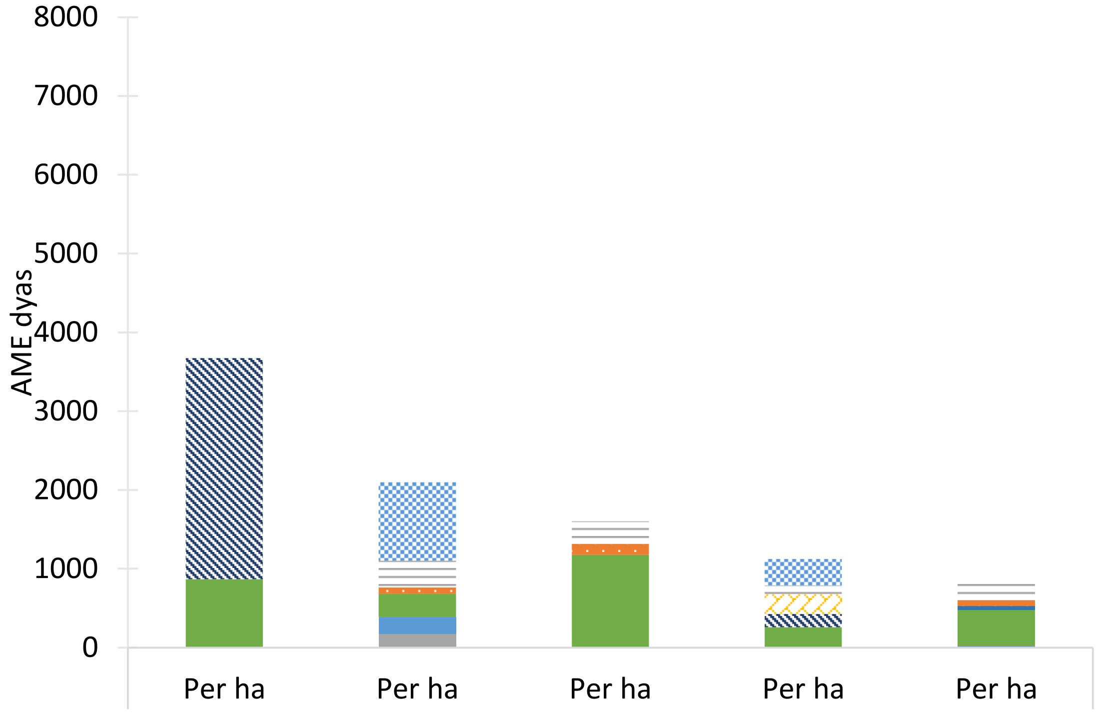
Stakeholders listed most relevant soil protection and rehabilitation technologies

- Reduced tillage and mulch
- Intercropping, double cropping and rhizobia
- Small-scale mechanization
- Quality seeds & improved agronomy (including fertilizer and liming)

Picture: Stephanie Malyon, CIAT

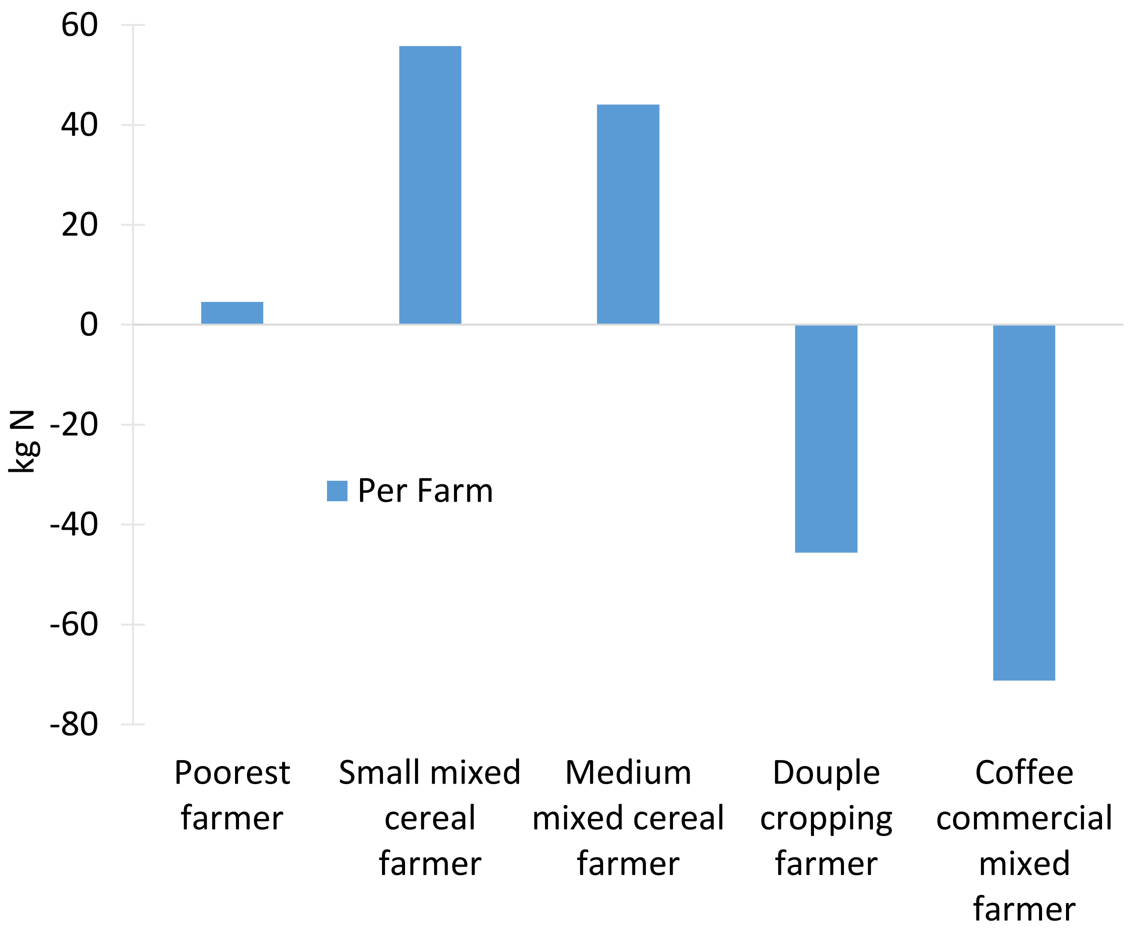
Calories produced on farm –baselines

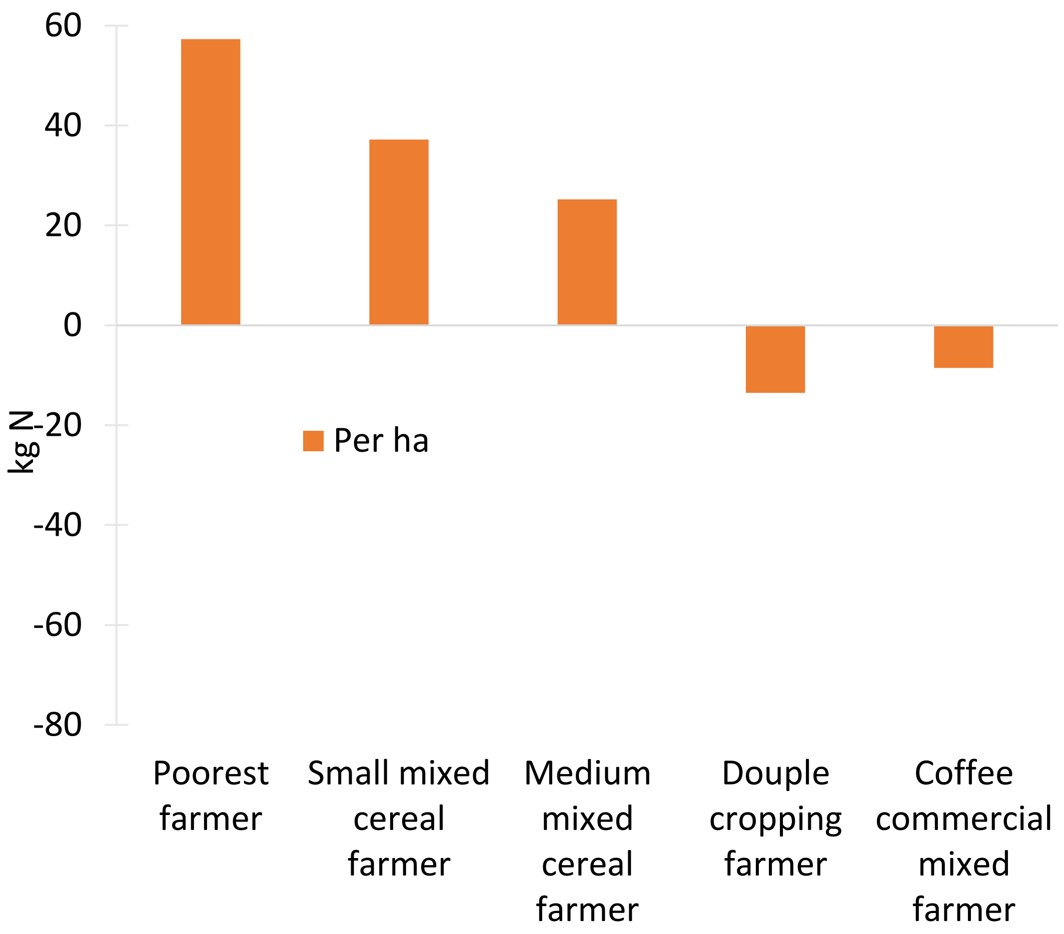




Unit is in AME days (2500kcal per day are required)
Diversity of production
Higher production intensity on smaller farms (high energy crops-staple crops)
But coffee does not count towards Kcal but does to cash

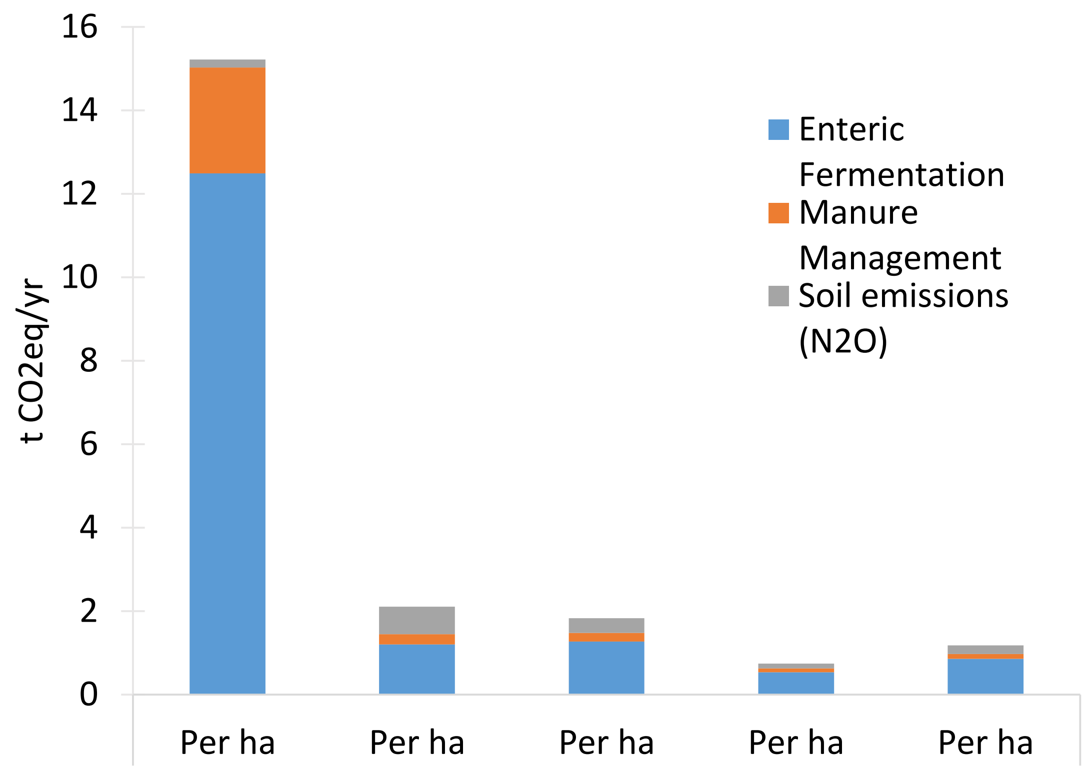
Nitrogen balance-baselines





- Level of inputs→ Manure from high livestock density productions (smaller farms)
- On large farms large inputs levels do not necessarily compensate for large crop product outputs → mining even at low rate is a problem over long term

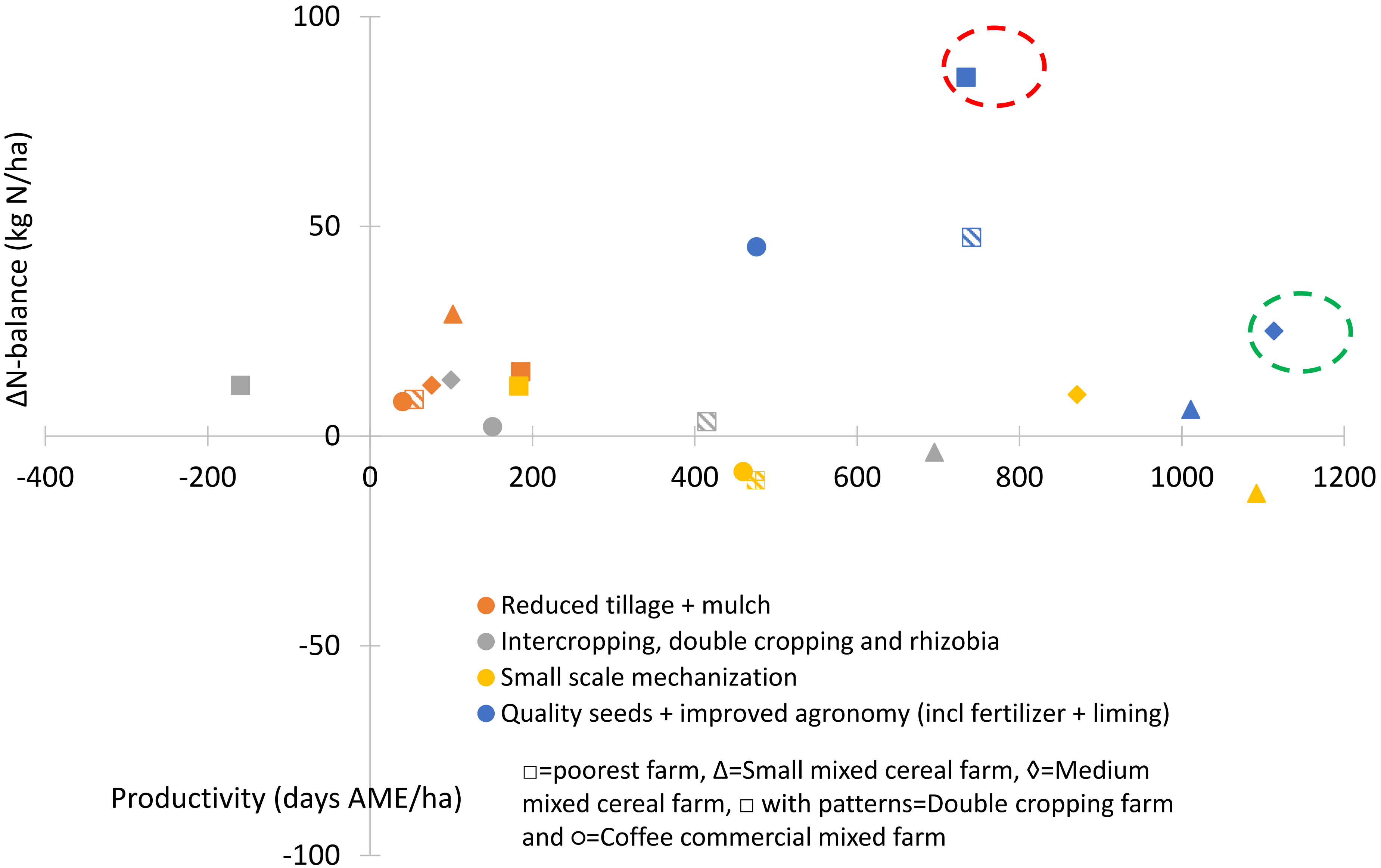
Greenhouse gas emissions - baselines



- Livestock is the largest contributor to GHG emissions (enteric+manure)
- The livestock density on farm can highly influence the levels esp. on small farms
- Yet GHG levels are low
- However, some emissions are not included in these calculations and could be considered in further research: off-farm emissions from fertilizer production and mechanization emissions

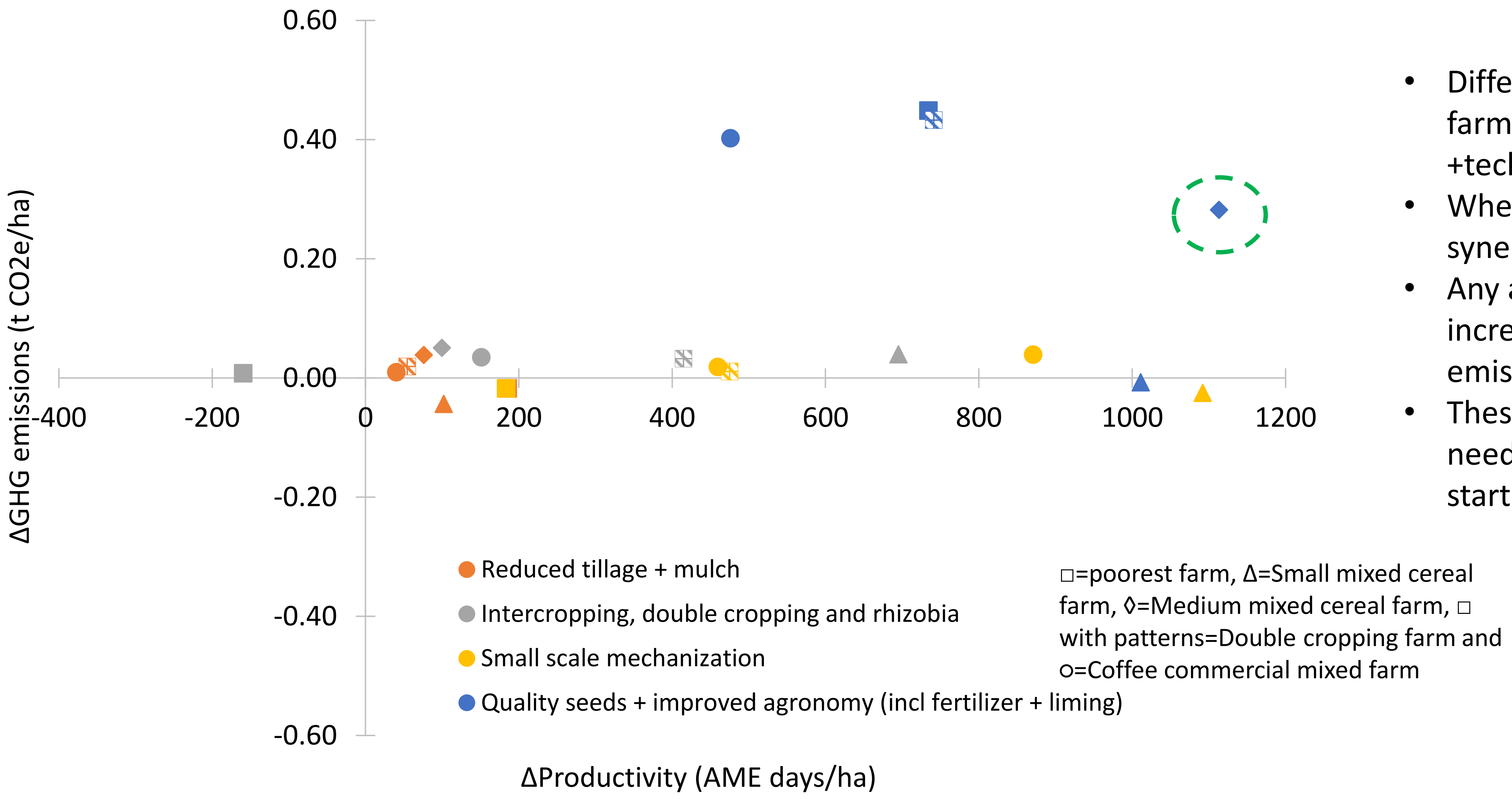
  -> difficult to estimate

Trade-offs: Productivity vs. N balance



- Different responses: farm type +technologies
- Where are the synergies?
- These are changes -> need to consider the starting point

Trade-offs: Productivity vs. GHG emissions



- Different responses: farm type +technologies
- Where are the synergies?
- Any addition of N will increase N2O emissions
- These are changes -> need to consider the starting point

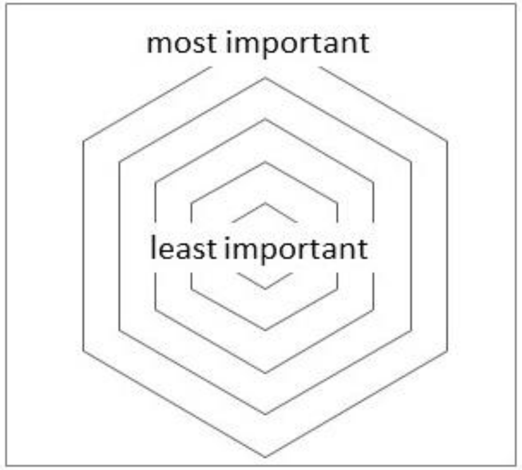
Evaluating Land Management Options (ELMO)

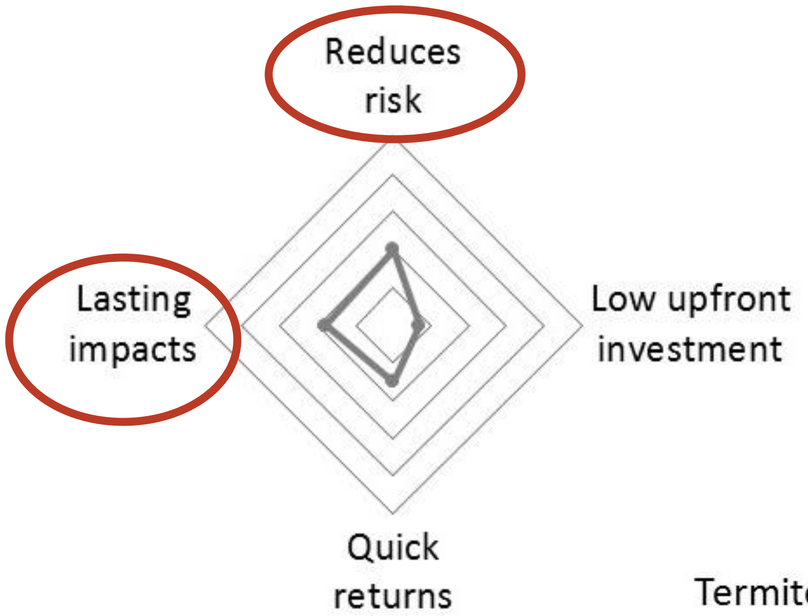
Participatory tool for assessing farmers' land management (LM) decisions, preferences & trade-offs

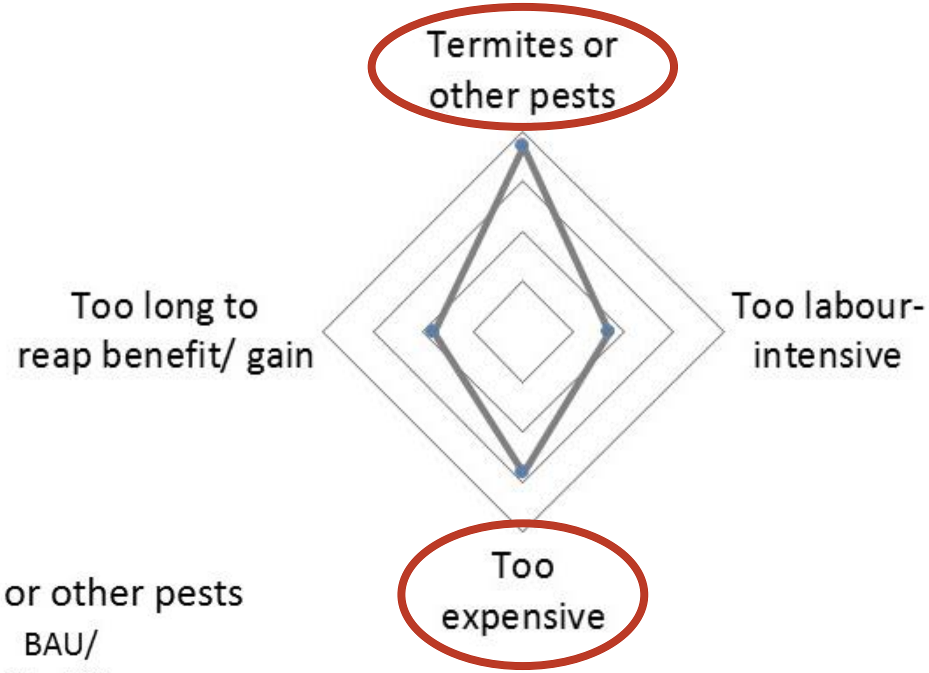
1. Identify techniques & attributes to be discussed
2. Record respondent characteristics
3. Define LM techniques & baseline
4. Rank & Score LM costs & input requirements
5. Rank & Score LM benefits & desired outcomes
6. Rank LM advantages & positive attributes
7. Rank LM disadvantages & negative attributes
8. Rank and weight LM alternatives overall

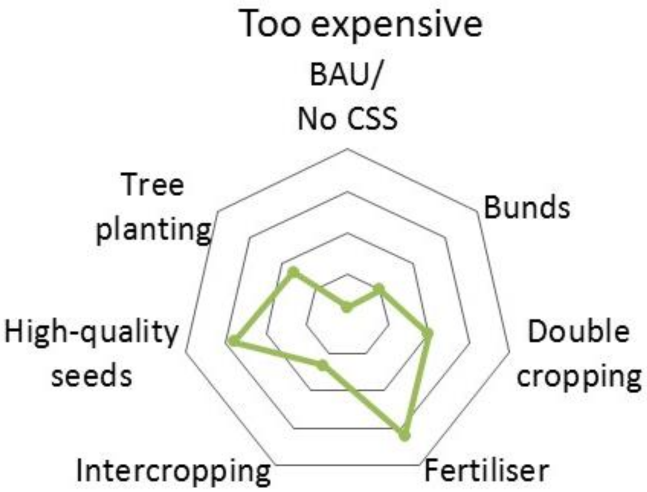
Individual discussions with farmers

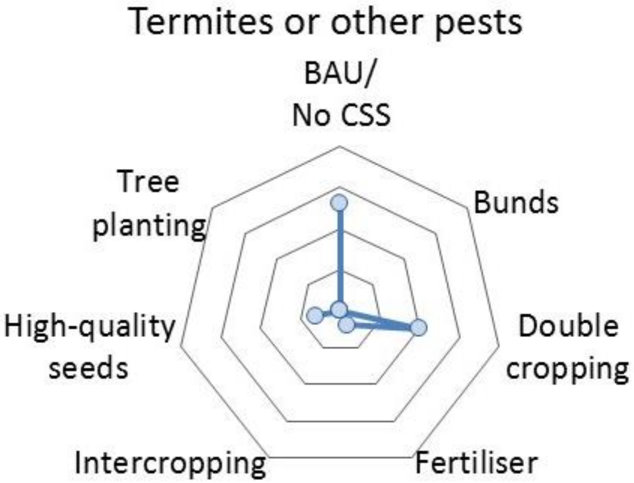
Relative importance of advantages & disadvantages of practices





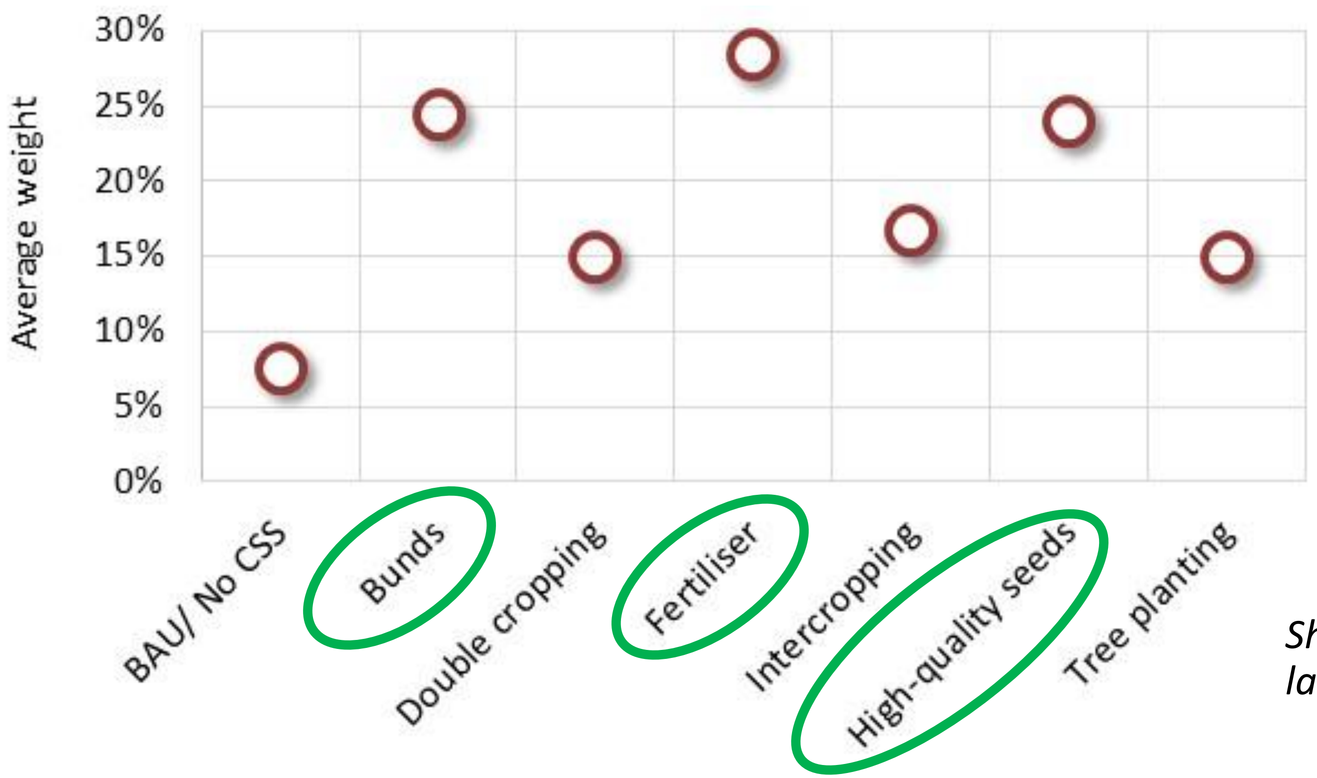


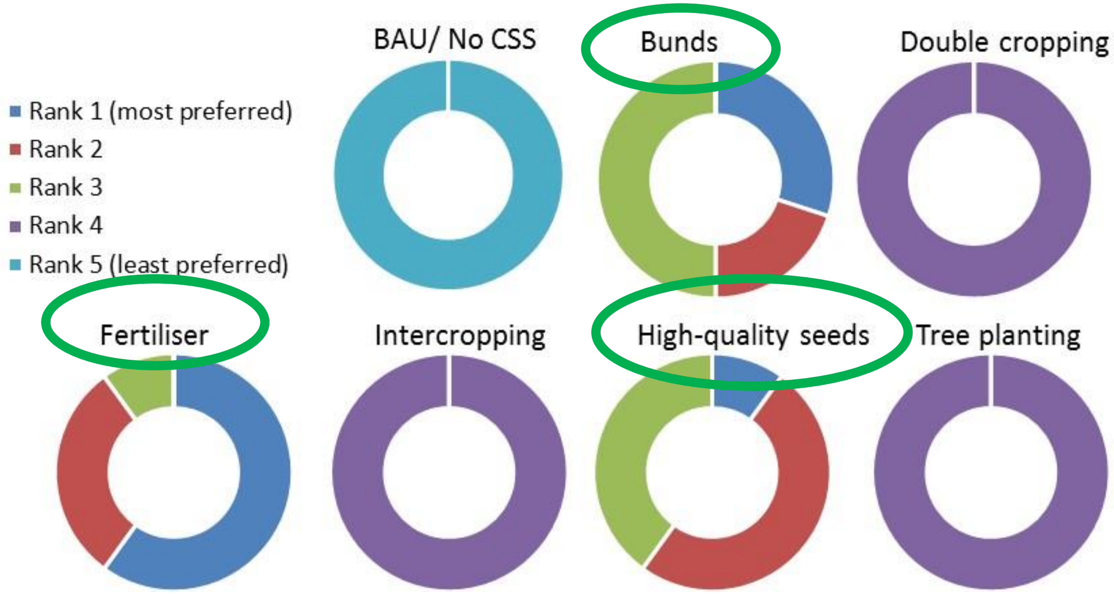




Shows average scoring by farmers

Overall preference of practices





Shows percentage of respondents allocating different ranks to each land management practice.

Shows average weight attributed according to overall preference relative to other land management practices. Note that total exceeds 100%, because interviews cover different combinations of land management practices.

Features that make a practice workable for farmers include the ability to lead to **tangible improvements in crop yields and soil fertility**

The **risk of bringing termites or other pests** was emphasized as among the most important negative attributes that would make a practice less attractive or unworkable.

Calculating attainable impact across the two regions

1. Number of farm households of each farm type

   ~ rural population / HH-size * farm type %

	Poorest farmers	Small mixed cereal farmers	Medium mixed cereal farmers	Double cropping farmers	Coffee commercial mixed farmers
%	12.2	38.4	32.8	4.9	11.7
Number HHs	937,278	2,959,247	2,531,545	379,165	900,075

2. Adoption rates (% of the HHs likely to adopt the specific intervention) per farm type ~ ELMO

20% or

Reduced tillage and mulch	Intercropping, double cropping and rhizobia	Quality seeds, improved agronomy	Small-scale mechanization
10	*15*	*24*	*10*
currently doesn't seem to be known or interesting to the farmers	*"double-cropping" score*	*"high quality seeds" score*	*currently doesn't seem to be known or interesting to the farmers*

Calculating attainable impact on productivity (AME days)

3. Number of adopting farms x estimated impact per farm assuming a 20% adoption rate across all technologies and regions

	Intercropping, double cropping and rhizobia	Quality seeds, improved agronomy (incl. fertilizer and liming)	Reduced tillage and mulch	Small-scale mechanization
Coffee commercial mixed farmers *180K*	226.36M	713.76M	60.48M	689.00M
Double cropping farmers *76K*	106.22M	189.75M	14.37M	121.58M
Medium mixed cereal farmers *506K*	88.52M	986.6M	67.48M	771.69M
Poorest farmers *187K*	2.39M	0.00M	2.79M	2.75M
Small mixed cereal farmers *592K*	617.34M	897.69M	90.65M	969.52M

Calculating attainable impact on productivity (AME days)

- Assuming the ELMO adoption rates

	Intercropping, double cropping and rhizobia	Quality seeds, improved agronomy (incl. fertilizer and liming)	Reduced tillage and mulch	Small-scale mechanization
Coffee commercial mixed farmers *900K*	169.77M	981.41M	30.24M	344.50M
Double cropping farmers *379K*	79.67M	189.75M	7.19M	60.79M
Medium mixed cereal farmers *2.5 million*	77.46M	1184 M	33.74M	385.85M
Poorest farmers *937K*	1.79M	0.00M	1.39M	1.38M
Small mixed cereal farmers *2.9 million*	463.00M	1,122.11M	45.32M	484.76M

Trade-offs with GHG emissions

N balance

	Intercropping, double cropping and rhizobia	Quality seeds, improved agronomy (incl. fertilizer and liming)	Reduced tillage and mulch	Small-scale mechanization
Coffee commercial mixed farmers	2.45M	92.95M	6.13M	6.39M
Double cropping farmers	0.64M	12.12M	1.11M	1.35M
Medium mixed cereal farmers	10.35M	27M	5.35M	4.37M
Poorest farmers	0.14M	0.00M	0.11M	0.09M
Small mixed cereal farmers	2.55M	7.01M	12.89M	6.05M

GHG emissions

	Intercropping, double cropping and rhizobia	Quality seeds, improved agronomy (incl. fertilizer and liming)	Reduced tillage and mulch	Small-scale mechanization
Coffee commercial mixed farmers	0.04M	0.83M	0.01M	0.01M
Double cropping farmers	0.01M	0.11M	0.00M	0.00M
Medium mixed cereal farmers	0.04M	0.3M	0.02M	0.02M
Poorest farmers	0.00M	0.00M	0.00M	0.00M
Small mixed cereal farmers	0.03M	0.01M	0.02M	0.01M

Conclusions

- True triple-win technologies are rare: gains in productivity are met with increases with GHG emissions
- However GHG emissions are comparatively low and should not be of concern
- Entry point would be livestock for mitigation
- Positive N-balances need to be examined and discussed further, as some case study farms seem to deviate from the norm.
- No account for carbon (C) sequestration in soils as a consequence of reduced tillage and surface residue retention in this RA Such
    - potential to completely offset nitrous oxide emissions from soils.
- Features that make a practice workable for farmers include the ability to lead to tangible improvements in crop yields and soil fertility.
- The risk of bringing termites or other pests was emphasized as among the most important negative attributes that would make a practice less attractive or unworkable.
- At regional scale, quality seeds+ improved agronomy would impact the productivity and N balance the most across all farm type however at the highest cost in terms of GHG


Thank you!

CSA prioritization framework