



Assess whole-farm trade-offs and synergies for climate-smart agriculture



Summary

- » Research shows that climate-smart agriculture (CSA) is beneficial in increasing productivity, promoting resilience and reducing greenhouse gas emissions.
- » Achieving benefits in all three dimensions is difficult, and so necessary choices among competing investments and objectives must be made.
- » The complex nature of agricultural systems implies that there are always multiple outcomes and goals to choose from. Some are immediate whereas others are long term. Achieving some goals might compromise the ability to achieve others.
- » To invest in and scale up successful interventions, evidence is needed to help select and assess benefits and limitations of different CSA interventions.
- » Using this evidence to design portfolios of best-bet CSA options enables decision makers to identify and manage expectations, make informed choices and anticipate trade-offs.



Outcome

Evidence-based trade-offs assessment generates sets of interventions best suited to whole-farm choices.

What?

The broad goal of CSA is to reach a triple win: improve productivity, adaptation, and mitigation. Thus, trade-off analysis is required at every level of the decision-making process, from farmer to policy level, and all stakeholders need to be equipped with the right information to scale up appropriate evidence to meet the specific local need.

Farmers do not farm crops in isolation: they carry out many different practices on one piece of land. A whole-farm evaluation is needed taking into account crop, livestock, and aquaculture subcomponents before trade-offs can be suggested.

The trade-off analysis approach involves evaluating trade-offs, synergies and impacts of CSA adoption by looking at the whole farm within a diverse population of households. There is always an opportunity cost – a difference in net returns associated with changing from the current (not CSA) system to an alternative CSA technology. As a result, outcomes are associated with adoption and therefore with opportunity costs.

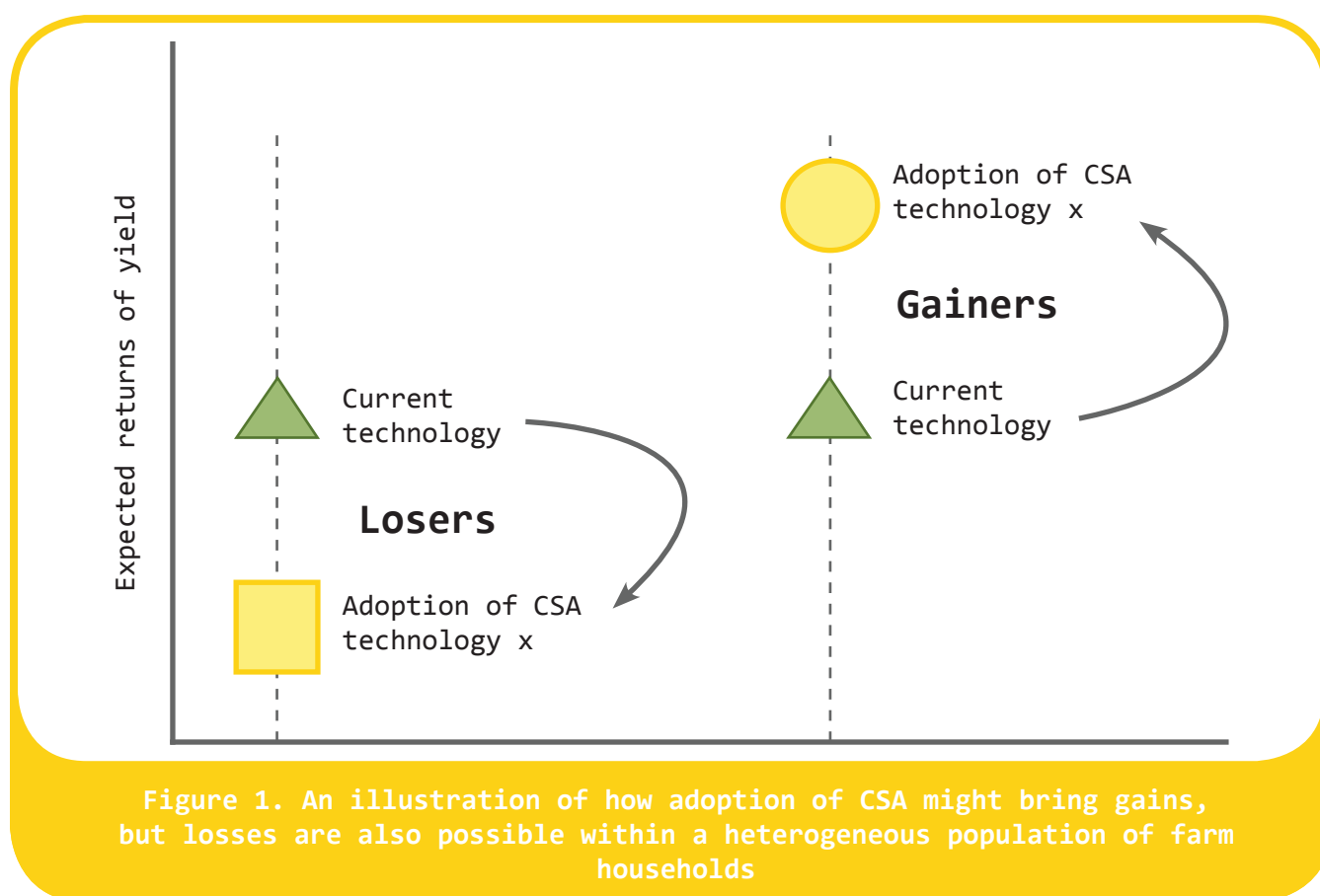


The process includes:

- »» 1. Identification of impact indicators representing a measure of economic, environmental, or social outcomes that stakeholders want and that are associated with the three CSA pillars (see brief 0).
- »» 2. Taking a whole-farm system approach by comparing crop, livestock, and aquaculture components, and off-farm activities and alternatives where CSA technology has been adopted.
- »» 3. The economic, environmental, and social impacts of the rate of CSA adoption is estimated.
- »» 4. Impacts associated with adoption to determine which households will gain from the CSA technology and those who will lose i.e. are better off in the current farm system – are compared.

Why?

- Quantification of trade-offs and synergies acknowledges that agricultural systems are diverse, and constitute varying biophysical (refer to CSA lesson brief 8) and socioeconomic conditions (refer to CSA lesson briefs 1 & 2).
- In the adoption of any agricultural technology in a particular context, there may be trade-offs. In a drought-prone region, the promotion of a drought tolerant (DT) crop variety may improve the household's ability to withstand climate shock, translating into better climate adaptation. Adoption may bring labor burdens due to the increased time needed for the agronomic practices that accompany the DT variety. If labor is a binding constraint and there is limited availability of hired labor, the adoption of the DT maize will increase the socioeconomic vulnerability of households. In some cases, using different technologies might offset trade-offs. However studies have shown that distributional impacts may vary within the population of farm households (Figure 1).



- All the possible impacts of different CSA practices in a particular context must be understood because these influence the adoption decisions taken by farm households. Adoption rates are positively correlated with anticipated positive returns on desired outcomes for farming households.
- Trade-off analysis helps to estimate the proportion of the population that gains or loses when a CSA technology is adopted.

How?

1

➤ We need to estimate the effects of farms adopting a new technology. First, expected returns for all farm subsystems based on their impact indicators, for example yield, price, cost of production, land allocation, labor use and income are estimated. This provides evidence of the economic, environmental and social outcomes associated with the adoption. Then, aggregate expected returns for adopters versus non-adopters are compared to highlight the proportion of farms for which the adoption of the CSA technology is economically feasible.

2

➤ Graphically, outcomes within and between the three CSA pillars are illustrated in Figure 2. Ideally CSA seeks to promote a win-win outcome but trade-offs can also occur. For example in option B, there is a gain in productivity and adaptation, and a loss in mitigation. Option F presents a gain in adaptation and a loss in both productivity and mitigation. Option H is not desirable as it compromises all the three pillars i.e. non CSA.

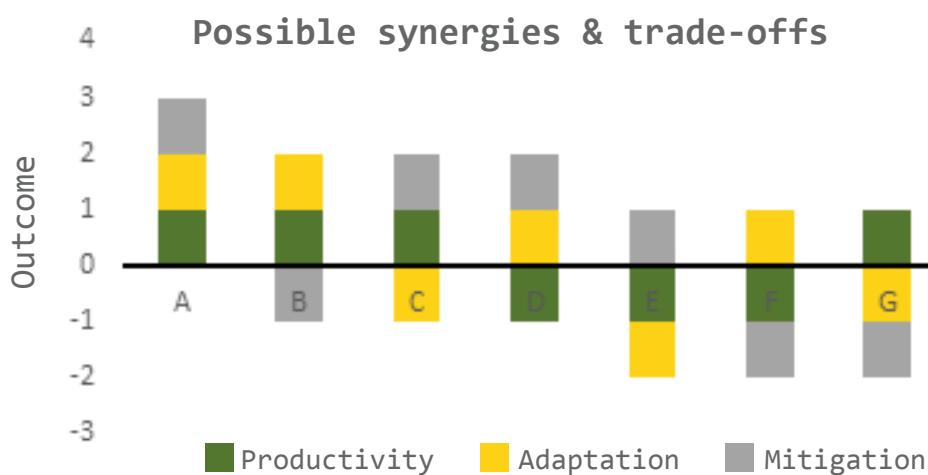


Figure 2. An illustration of how CSA can generate synergies and trade-offs across the CSA pillars

3

➤ The trade-off analysis approach provides decision makers with quantitative information on trade-offs and synergies associated with the adoption of different CSA practices.

4

➤ The trade-off analysis can be conducted using several approaches such as statistical analysis, econometric analysis, economic-statistical simulation, and bi-economical models.

5

➤ Providing information on trade-offs and synergies to decision makers improved CSA priority setting and enhanced the likelihood that the CSA investment would get positive outcomes within a particular context while mitigating any unintended adverse outcomes.



Estimating the effect of adopting prioritized CSA practices in Tanzania

In Kilolo and Mbarali districts of Tanzania, farmers prioritized the adoption of minimum tillage, improved crop varieties and integrated pest management. An estimation of expected impacts from adopting the three CSA technologies was then conducted using econometric analysis (Figure 3). The analysis showed that all technologies contributed to an increase in farm income, which was a benefit to the productivity pillar. However, adopting minimum tillage, as a single technology or in combination with the other two technologies, also led to labor saving. Thus it is clear that synergies exist in the adoption of minimum tillage. However, the adoption of improved varieties and integrated pest management increased labor use by the farms, suggesting such a combination would create the trade-off.

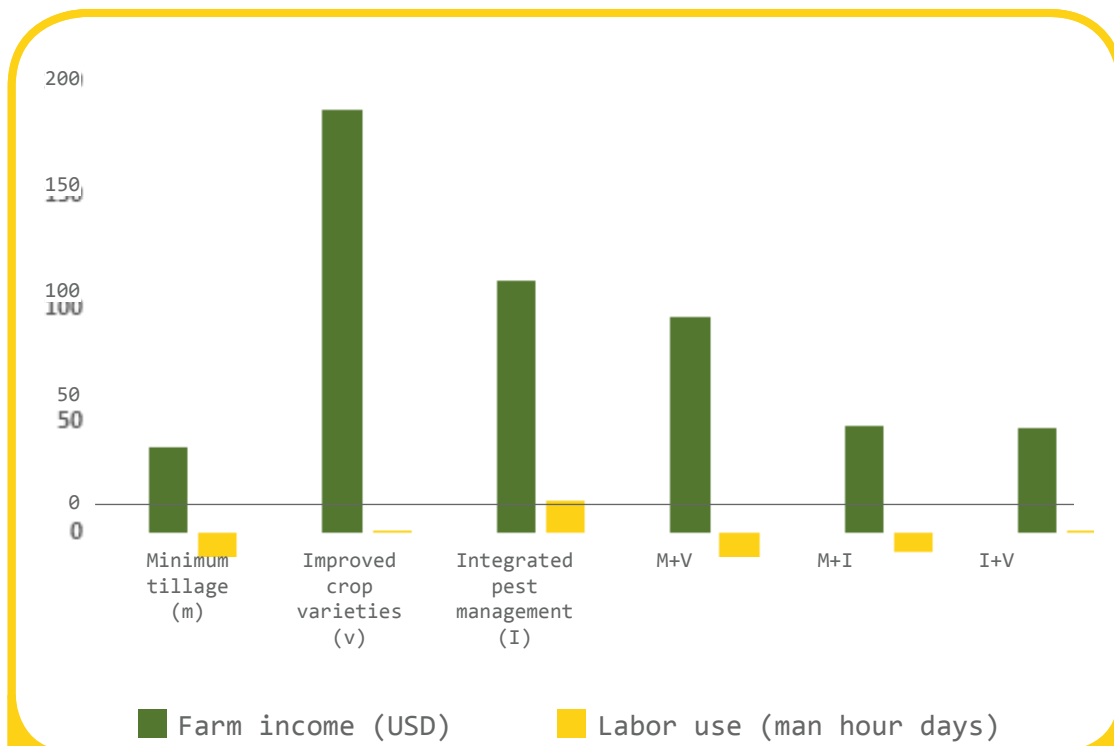


Figure 3. Impact of adopting selected CSA technologies on income and labour use in Kilolo and Mbarali districts, Tanzania

Assessing impacts of alternative livestock management options in Lushoto, Tanzania

We used the Ruminant model and the trade-off analysis model for multi-dimensional impact assessment (TOA-MD) to assess how improved livestock management options affected the three pillars of CSA: increased productivity, improved food security, and reduced greenhouse gas (GHG) emissions (Table 1). We observe gains (synergies) in the three pillars when we compared the base system and improved system (CSA adopters).



Table 1. Predicted adoption rates and simulated impacts of improved livestock system in Lushoto, Tanzania.

Indicators	Type of farm	Base system	Improved (CSA) System	
			Improved quality of diets	Improved quality & quantity of diets
Predicted adoption rates (%)	Only local cattle	n/a	58.0	62.0
	Improved cattle	n/a	67.0	76.0
Average farm income (USD/year)	Only local cattle	728	968.2	1011.9
	Improved cattle	1116	1651.7	1986.5
Food insecure households (%)	Only local cattle	21.7	15.2	14.8
	Improved cattle	13.9	12.0	12.0
Poverty rate (%)	Only local cattle	92.9	86.5	84.6
	Improved cattle	80.1	66.0	38.9
Methane emission intensity (CH ₄ per L. of milk per year)	Only local cattle	27.8	20.0	18.6
	Improved cattle	24.7	18.8	17.8



More information

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