CIMMYT International Maize and Wheat Improvement Center | SIMLESA Sustainable Intensification of Maize - Legume Cropping Systems for Eastern and Southern Africa

Australian Government
Australian Centre for International Agricultural Research

# Sustainable intensification based CA for sustainable food security and poverty reduction: Evidences from SIMLESA

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ICRISAT | ASARECA | The University Of Queensland | QAAFI | ARC • LNR

# SIMESA Vision of Success

**To increase maize and legume yields by 30% while sustaining the environment through:**

- Conservation agriculture practices
- Improved maize and legume varieties
- Development of markets and value chains, from input supplies to output markets.

**To reduce downside yield risks by 30%**

**To benefit 650,000 farm households** within 10 years.

# Benefits of CA : What we learnt and know

Conservation agriculture (CA) generates economic, environmental and risk reduction benefits. These benefits of CA are achieved through:

- effective use of resources (e.g., water, labor, and nutrients),
- reduction in crop losses to pest, disease and weed infestations
- reduction in soil erosion, increases in soil productivity, better water holding capacity of soils,
- consumption and production diversification,
- enhanced carbon sequestration, and/or
- better adaptation to local agro-climatic conditions.

In SIMLESA-1, efforts have been made to examine the role of CA in terms of yield and crop income increase, improving environmental quality, and risk reduction using comprehensive household survey and exploratory trials data.

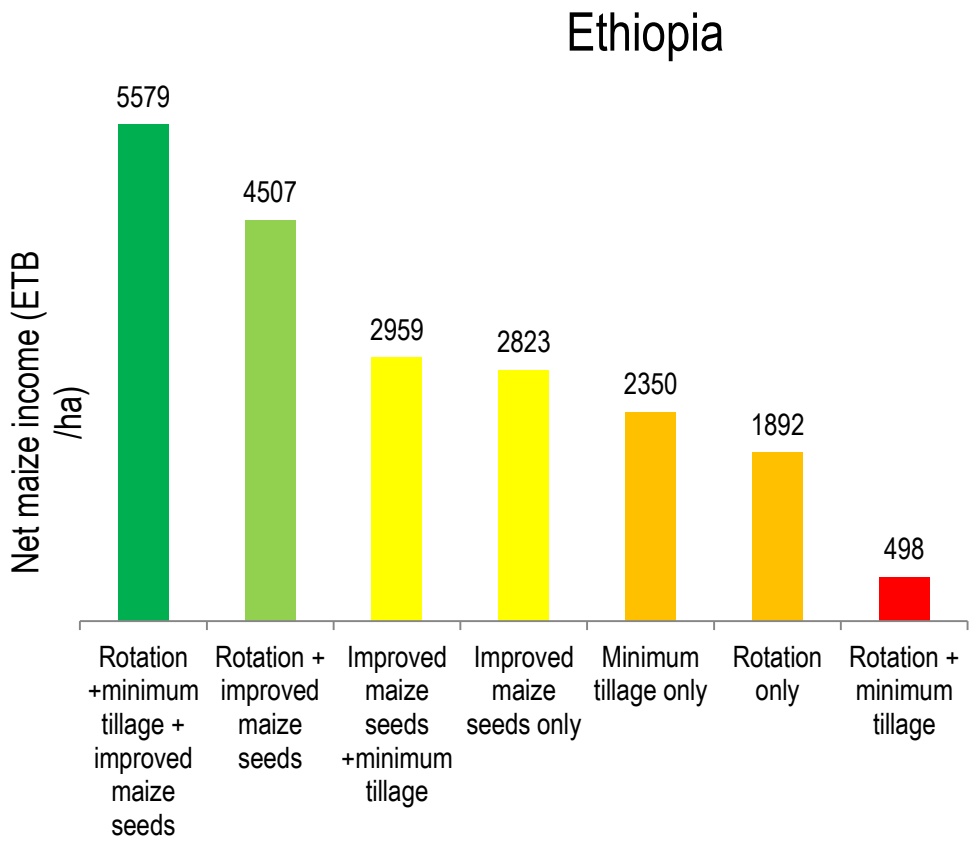
## Economic benefits of CA options Field level evidences

- In Ethiopia using the baseline survey data collected from 900 farm households we examined the impact of the adoption of CA options (maize-legume rotation and minimum tillage with some residue retention) in combination with improved maize varieties on net maize income. This is the net maize income after fertilizer, seed, labor and pesticide costs have been accounted for.

- The empirical evidence showed that the adoption of CA options increased net maize income by about 9-35% compared with non-adoption of these options
- This increases further to 47-67% when CA practices were adopted in combination with complementary inputs (e.g., improved maize varieties). The highest income was obtained when both CA practices were combined with use of improved maize varieties (Figure 1). The results were based on the counterfactual framework of intervention evaluation.

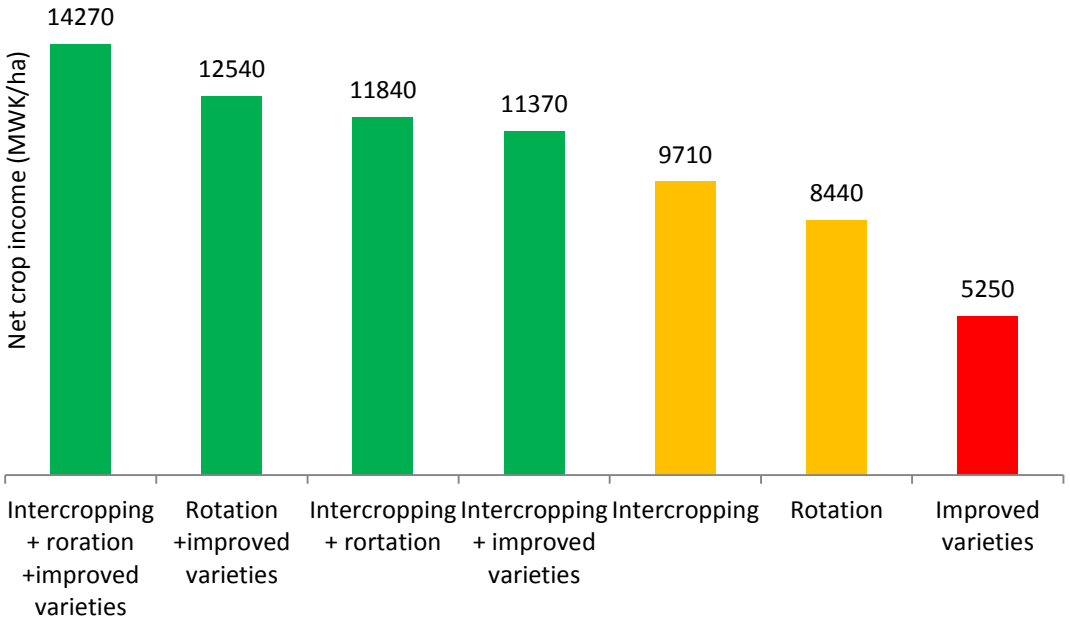
- Similarly, using 1925 sample farm households in Malawi, we also found similar evidence where combinations of CA components provided higher benefit than adopting them individually.

# Impact of agronomic practices on maize varieties performance-Net maize income

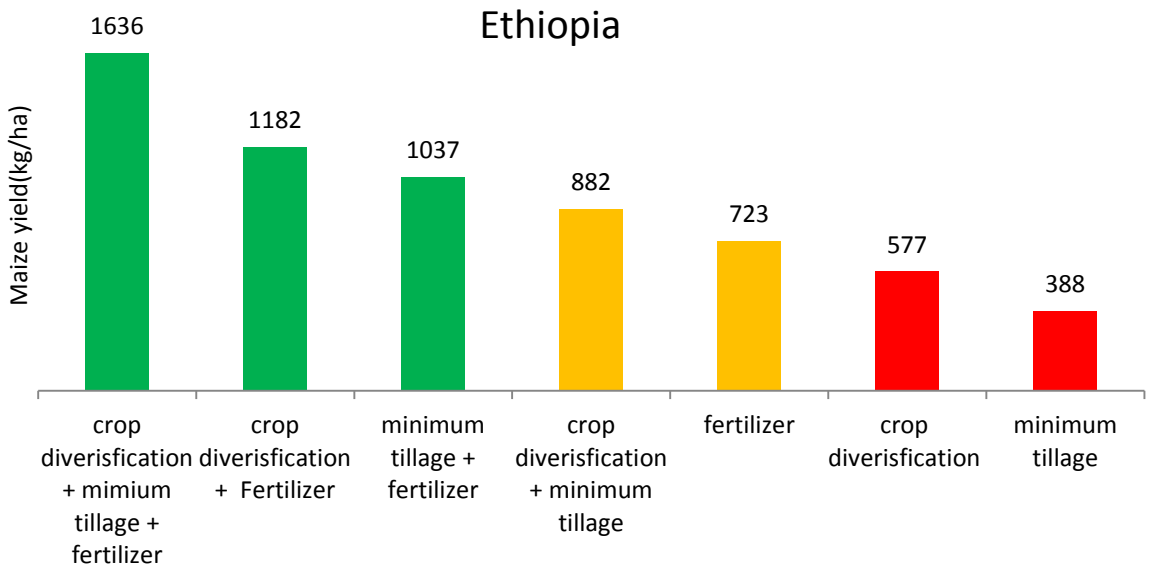


# Impact of agronomic practices on maize varieties performance-Net crop income

- Malawi



# Impact of agronomic practices on fertilizer performance (maize yield-kg/ha)



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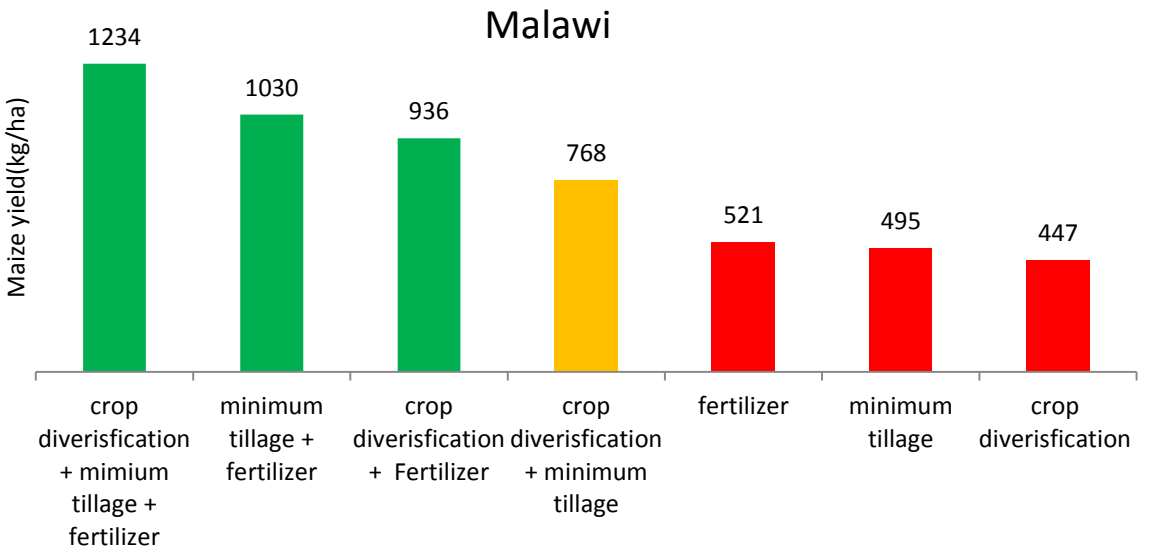
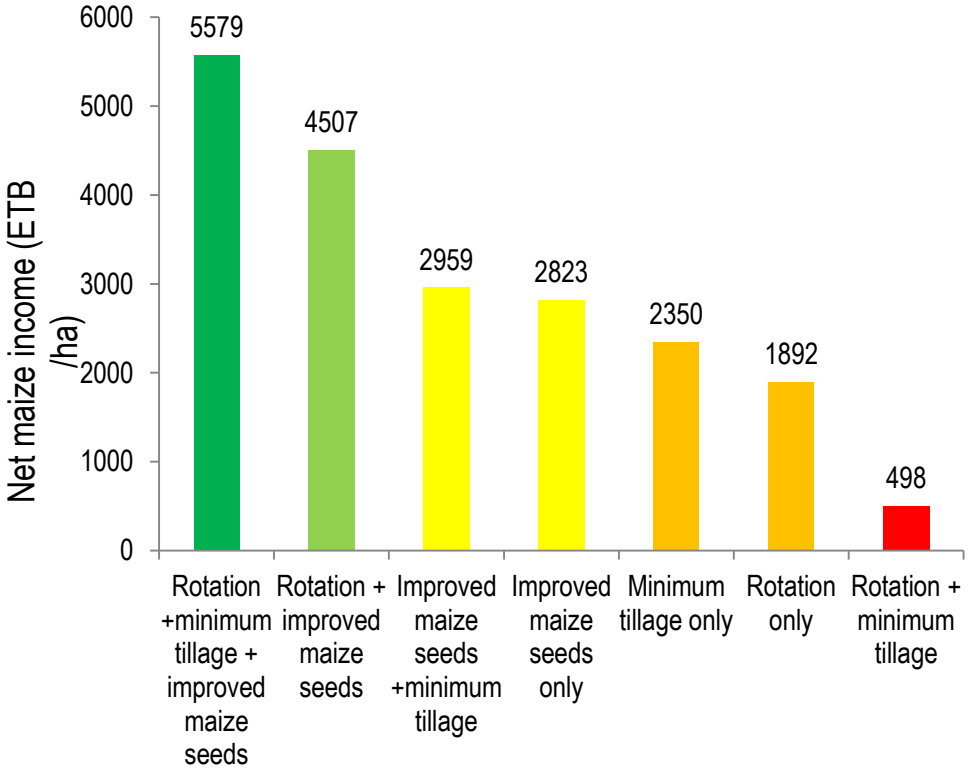


# Sustainable intensification(SI): Opportunities for the poor

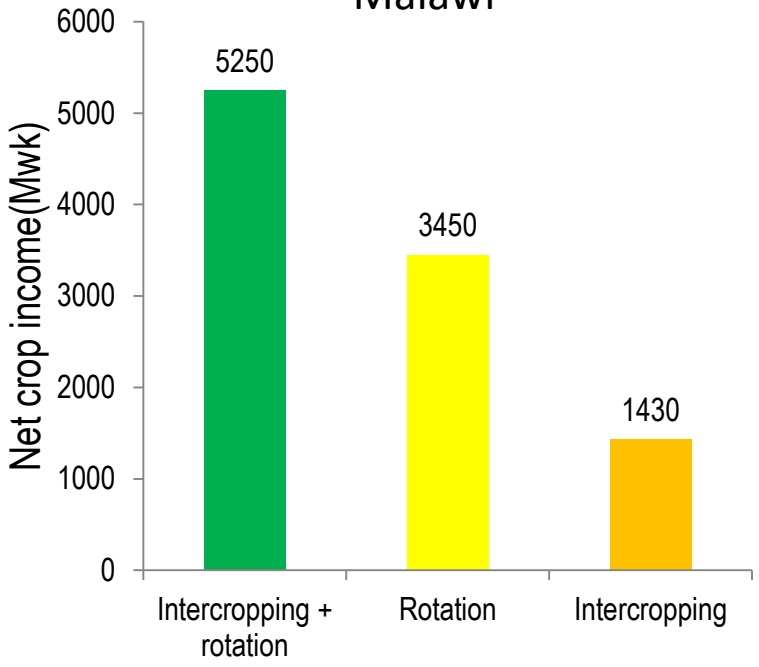
## Income opportunities

### Ethiopia




Source: Teklewold et al. 2013), Ecological Economics, 93: 85-93

### Malawi




Source: Kassie et al. (2013), submitted to environment and development Economics

# Cost and ecosystem services saving opportunities

# Sustainable intensification: Opportunities for the poor

## Ethiopia

| Package | N application (Kg/ha) | Pesticide application (l/ha) |
|---|---|---|
| $R_1V_0T_0$ | 9.45 | 0.59 |
| | (9.31) | (0.58) |
| $R_0V_1T_0$ | 3.78** | 1.04*** |
| | (2.29) | (0.06) |
| $R_0V_0T_1$ | -13.92*** | 2.95*** |
| | (2.89) | (0.49) |
| $R_1V_1T_0$ | 7.81 | 0.01 |
| | (6.72) | (0.13) |
| $R_1V_0T_1$ | -19.95*** | 3.42 |
| | (5.69) | (3.21) |
| $R_0V_1T_1$ | -5.60** | 0.84*** |
| | (3.57) | (0.09) |
| $R_1V_1T_1$ | 15.27* | 1.49*** |
| | (10.65) | (0.30) |

- R-maize-legume rotation, V-improved maize variety, T-minimum/ tillage with some residue retention, I-maize-legume intercropping
- Pesticides includes herbicides + insecticides

## Malawi

| Package | Participant subsidy program | | | Non-participant subsidy program | | |
|---|---|---|---|---|---|---|
| | Adoption status | | Adoption Effects | Adoption status | | Adoption Effects |
| | Adopting (j= 2,. . .,4) | Non-Adopting (j=1) | | Adopting (j= 2,. . .,4) | Non-Adopting (j=1) | |
| $T_1R_0$ | 20.09 (5.00) | 13.28 (5.59) | 6.82 (0.82)*** | 14.49 (8.19) | 17.53 (10.03) | -3.04 (0.98)*** |
| $I_0R_1$ | 31.15 (15.06) | 16.20 (4.56) | 14.95 (0.92)*** | 16.89 (8.72) | 22.81 (8.99) | -5.91 (1.23)*** |
| $I_1R_1$ | 26.63 (13.36) | 13.90 (5.36) | 12.73 (1.11)*** | 11.89 (20.78) | 16.37 (11.61) | -4.48 (4.08) |

| Package | Pesticide application (Lit./acre) | | |
|---|---|---|---|
| | Adoption status | | Adoption Effects |
| | Adopting (j= 2,. . .,4) | Non- Adopting (j=1) | |
| $I_1R_0$ | 0.07 (0.14) | 0.45 (2.59) | -0.38 (0.09)*** |
| $I_0R_1$ | 0.14 (0.36) | 0.81 (2.42) | -0.67 (0.12)*** |
| $I_1R_1$ | 0.09 (0.27) | 0.68 (2.71) | -0.59 (0.19)*** |

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# Environment saving opportunities

## Ecosystem benefits-Ethiopia

| Treatments | Soil loss (ton/ha) |
|---|---|
| Sole maize under farmers' practice | 5.21 |
| Maize-haricot bean intercropping under conservation agriculture(CA) | 1.80 |
| Sole maize + mulch+ CA | 1.95 |
| Maize-haricot bean intercropping with farmers practice | 2.71 |
| Maize-haricot intercropping under farmers practice | 3.44 |

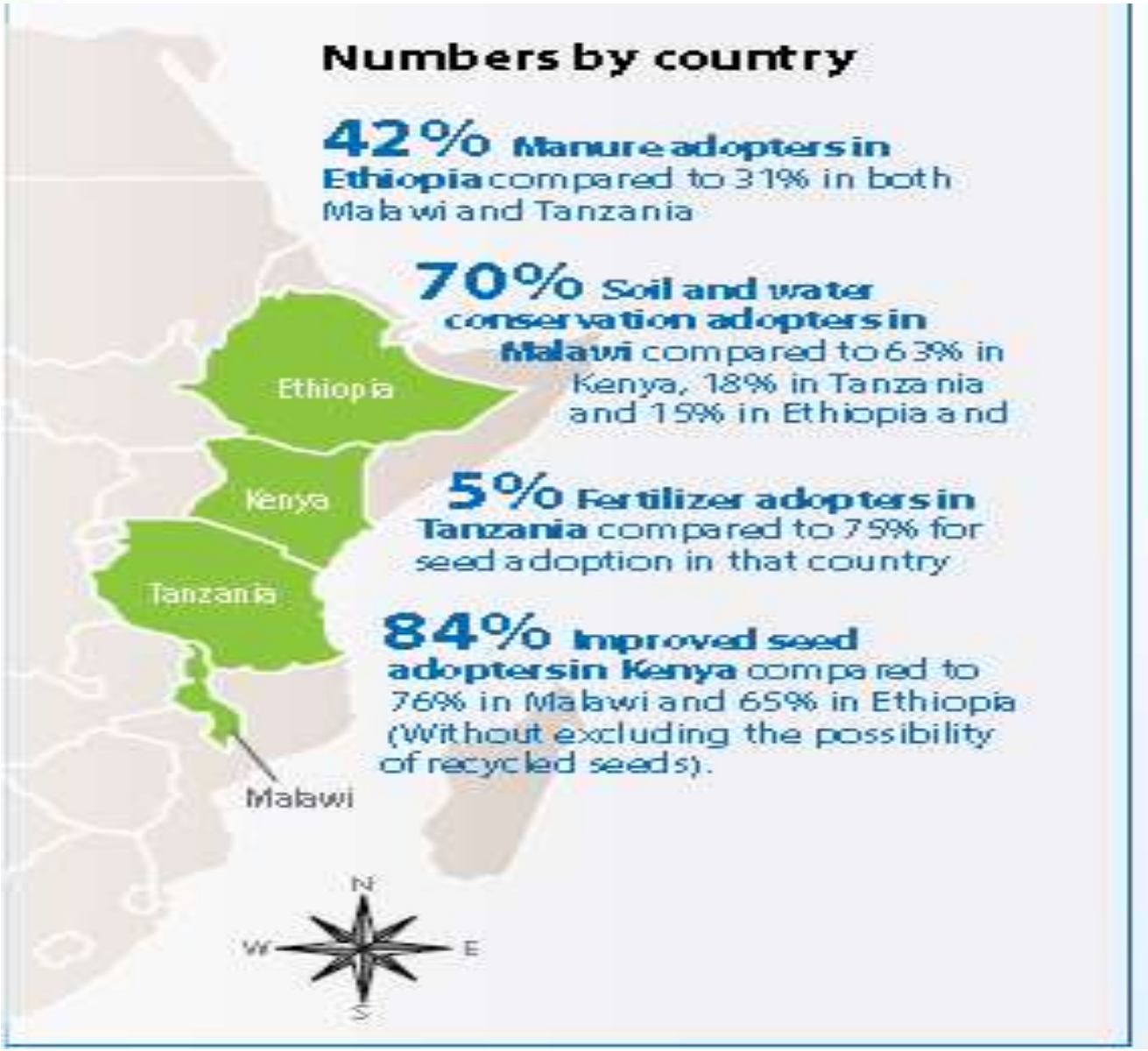
Source: Degfa (2013)

- SI options reduce soil loss in maize plots in the ranges of 34-65% compared with famers practice

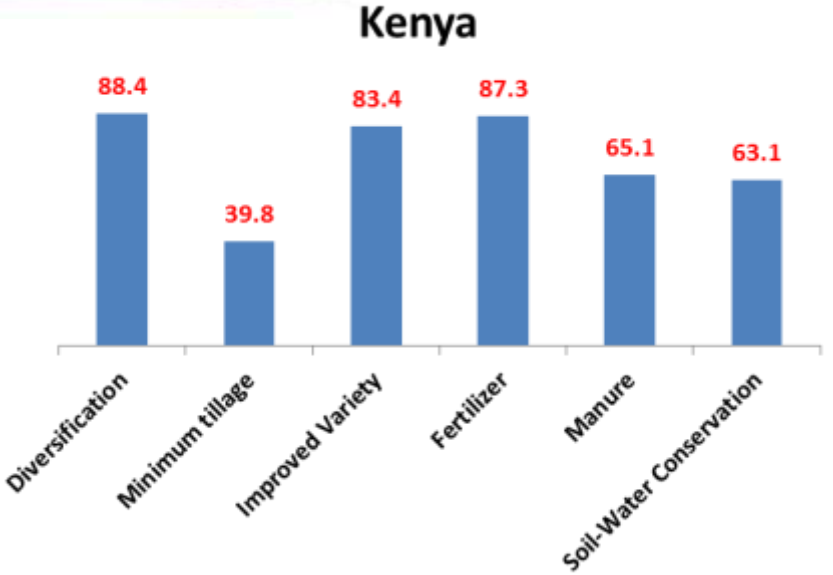
# SAI: The Building Blocks

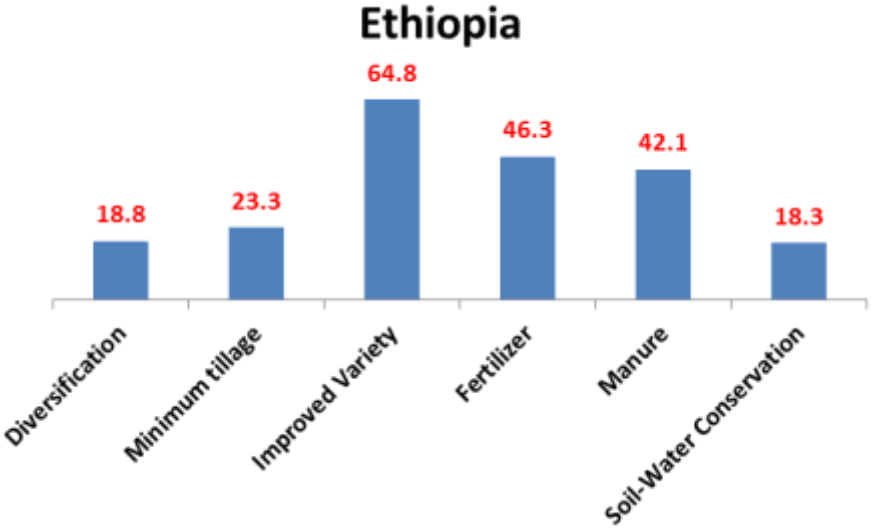
# SAI: Portfolio Management

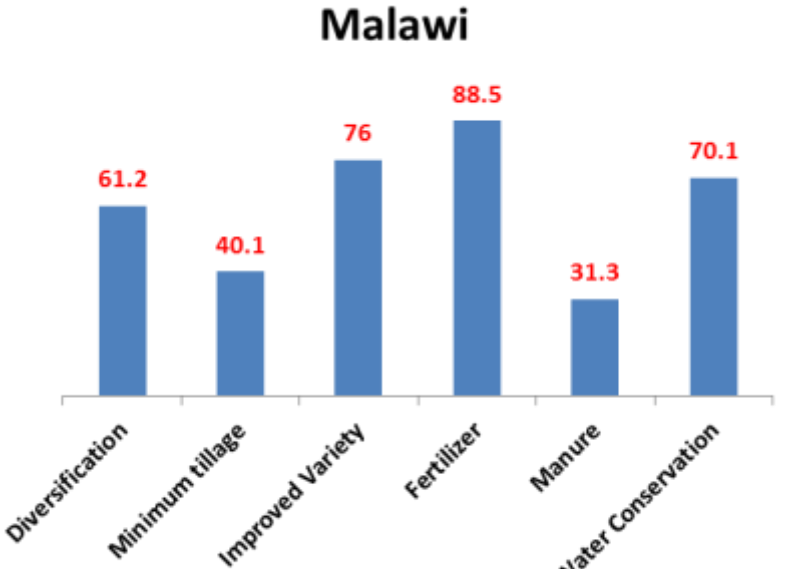
- A successful farm production system requires a portfolio of practices
  - Especially when complementarities are involved
  - *When a farmer adopts one practice then the propensity to adopt a complimentary practice increases and vice versa: all else equal*
  - example: If farmers cannot access quality maize seed will that not dampen the incentive for fertilizer use?
- If complementarities are strong: adoption of stand-alone practices will not achieve the desired productivity or environmental outcomes
- Use of Multivariate models to enable us to model adoption of complementary practices more accurately

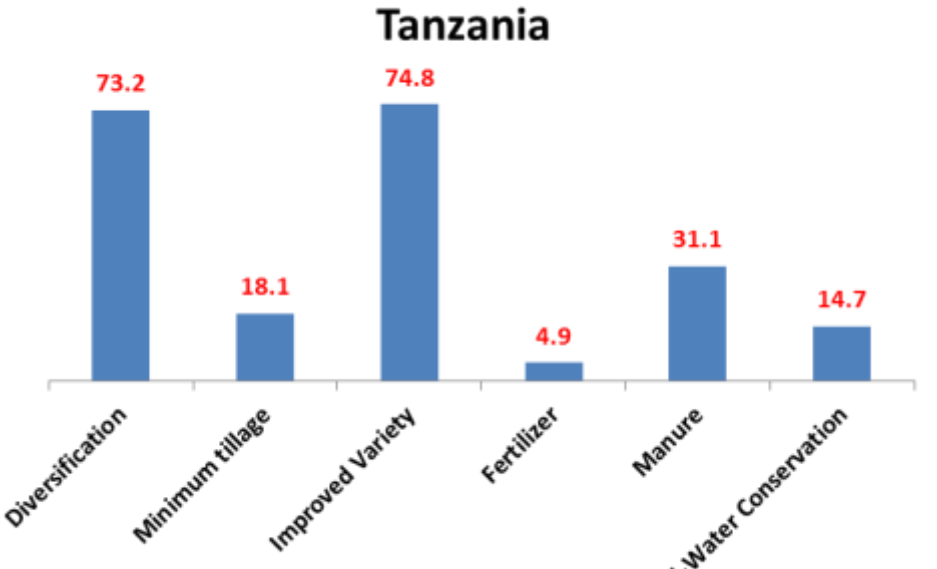

Numbers by country
42% Manure adopters in Ethiopia compared to 31% in both Malawi and Tanzania
70% Soil and water conservation adopters in Malawi compared to 63% in Kenya, 18% in Tanzania and 19% in Ethiopia and
5% Fertilizer adopters in Tanzania compared to 79% for seed adoption in that country
84% Improved seed adopters in Kenya compared to 76% in Malawi and 65% in Ethiopia (Without excluding the possibility of recycled seeds).
Ethiopia
Kenya
Tanzania
Malawi
N
W
E
S

# Household level adoption rates (%)



# The Correlations

- **Complementary relationship was observed between fertilizer use and improved variety in all countries.**

- **Substitutability:**
  - **Conditional probabilities of a household adopting fertilizer decreased by 4% in Malawi, 20% in Ethiopia, and 3% in Tanzania when farmers adopt manure.**

- **Complementarity:**
  - **The unconditional adoption rate of fertilizer was 4% in Tanzania, this increased by 1% if farmer adopted fertilizer jointly with improved variety or minimum tillage or both.**

  - **The adoption rate of fertilizer doubled from 4% where fertilizer alone were observed to 8% when fertilizer is used jointly with minimum tillage, soil/water conservation and improved variety.**

  - **In Ethiopia, the adoption rates of crop system diversifications and soil/water conservation was about 20% but went to up to 40% if other SIPS were adopted.**

# Some Variables Conditioning Adoption

| Group Membership | Proximity to Markets | Household Assets |
|---|---|---|
| Those farmers belonging to groups had higher chance to adopt:<br>• In Ethiopia: Crop diversification and minimum tillage<br>• In Kenya: Improved varieties and fertilizer<br>• In Malawi: Soil and Water Conservation | When close to markets farmers had a higher chance to adopt:<br>• In Ethiopia: Crop diversification and manure use<br>• In Malawi: Improved varieties<br>• In Tanzania: Crop diversification and minimum tillage | With more assets in the household farmers had a higher chance to adopt :<br>• In Ethiopia: Soil and Water Conservation<br>• In Kenya and Tanzania: Manure |

# Other Variables

- **Confidence in the *skill* of extension: need to improve extension workers' skill to supply quality information**

- **The positive correlation between *education* and the adoption of SIPs suggests that investments in rural public education will have payoffs.**

- ***Secure land access or tenure* was positively found to impact adoption. There is still room to improve on guaranteeing long-term tenure security to encourage adoption**
  - **Especially for SIPs with long gestation periods**

# Conclusions

- **We found complementarities between the SAIPs practices and substitutability**

- **This implies that:**
  - **Policies which affect adoption of a given SIP can have *spillover* effects on adoption of other SIPs**

  - **Complementary SIPs should be promoted as *packages* because partial adoption will not achieve expected outcomes.**

  - **Information on which SIPs are best adopted together or individually can help in formulating *correct packages for extension messaging***

# So therefore…

Given their interrelatedness, it is incumbent that policies or programs that support better seeds and fertilizer must also take on-board agronomic and natural resource management practices as indispensable adjuncts to sustainable intensification.