CIMMYT
International Maize and Wheat Improvement Center

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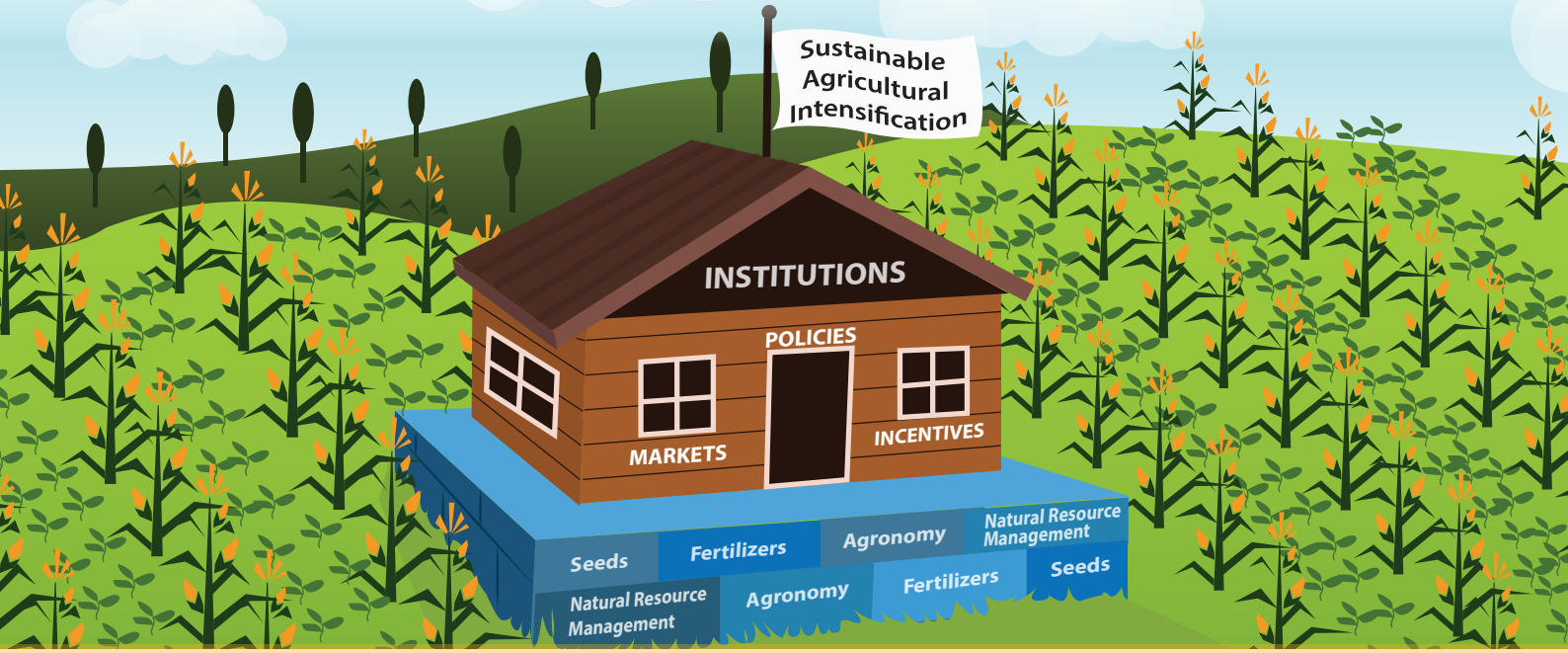
## Sustainable Agricultural Intensification in Eastern and Southern Africa:

# Evidence, Lessons and Imperatives for Scaling Up and Out




## Key messages

- Both field experiments and household analysis show that conservation agriculture (CA) can have a strong value proposition for farmers in terms of cost reduction, yield enhancement and risk mitigation
- CA can contribute to the provision of eco-system services such as soil loss mitigation
- To achieve CA, diffusion will require continuous demonstrations beyond experimental plots
- The information delivery system for CA should involve government extension, innovation platforms and other information providers

## Why focus on sustainable intensification?

The challenge of feeding a growing world population projected to reach 9 billion by 2050 has to involve sustainable agricultural intensification, with the key principles of resource conservation, resilient production systems and economic viability of those systems. These are some of the guiding principles behind the Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA) project, which was designed with a key objective of contributing to the "increase [of] production of maize and legumes in the region while confronting soil and land degradation and high levels of economic and climatic risk, accentuated by severe climate change impacts". The project has focused on generating multidisciplinary information from research on conservation agriculture (CA) based production options. In addition to analysis of value chains and constraints to technology adoption and farmers' participation in markets, testing new generation maize and legume varieties suited for CA-based systems for expedited release, and analyzing the economic merits of these new production methods. During the first phase of the project (2010–2014) substantial body of evidence and information have been generated. This brief summarizes some key strands of this information. The second phase of SIMLESA project revolves around utilizing these results in to inform policies to remove constrains to technology adoption, agribusiness and value chains development and ways to scale out promising production options.

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# A brief snapshot: Some key research from SIMLESA

## Is there a value proposition in CA for famers?

The productivity (yield) advantage of CA compared to farmer practices has been demonstrated in research under the SIMLESA project.

**3-21%**

**8-40%**

**5-18%**

**20%**

**19%**

### Malawi

- The range of Increase in maize yield in the mid-altitude agro-ecology.
- Increase in maize yield in lowland agro-ecology.

### Ethiopia

- The average increase in grain maize yield under CA options compared with farmers' practice.

### Mozambique

- Increase in maize yield while planting in basins relative to the conventional flat seeding on tilled seed bed.
- Increase in maize yield in Gorongoza under direct seeding.

## How do experimental results compare to observations from household surveys?

The experimental results are consistent with the results obtained using large household survey data in Ethiopia and Malawi. In Ethiopia, the empirical evidence using 900 farm households showed that the adoption of CA options increased net maize income by about 9-35% compared with non-adoption of these options (Figure 1). This increased further to 26-137% when CA practices were adopted in combination with complementary inputs like improved maize varieties. The highest income was obtained when both CA practices were combined with use of improved maize varieties. Similar results were observed in Malawi where using 1925 sample farm households, the analysis showed that the performance of CA options progressively improved when they were combined with improved maize varieties under a crop rotation system.

**9-35%**

Increased net maize income on adoption of CA

**26-137%**

Increased net maize income when CA practices were adopted in combination with complementary inputs

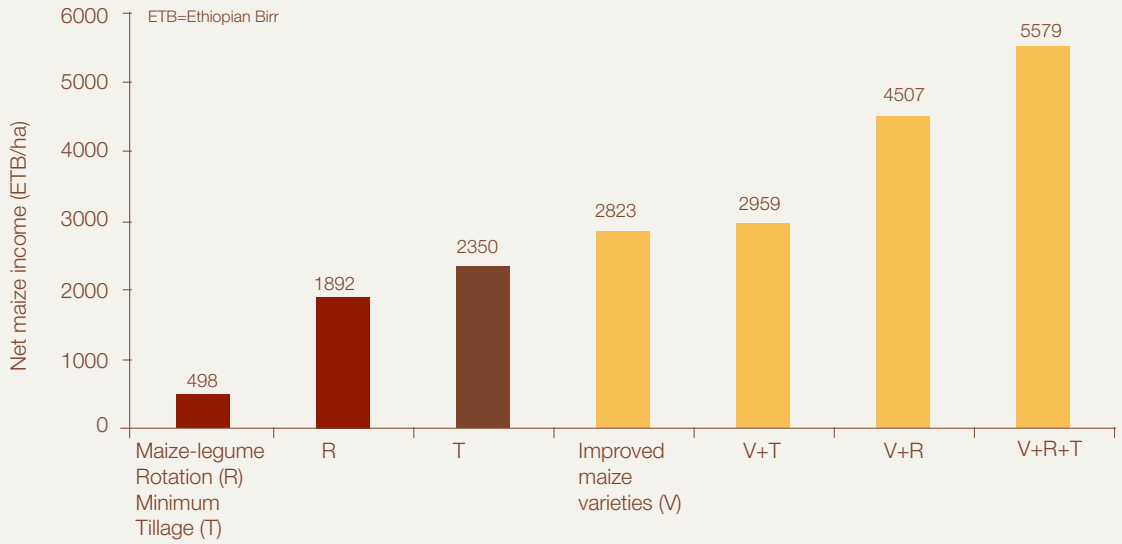



Figure 1: Impact of CA on maize income in Ethiopia from survey data

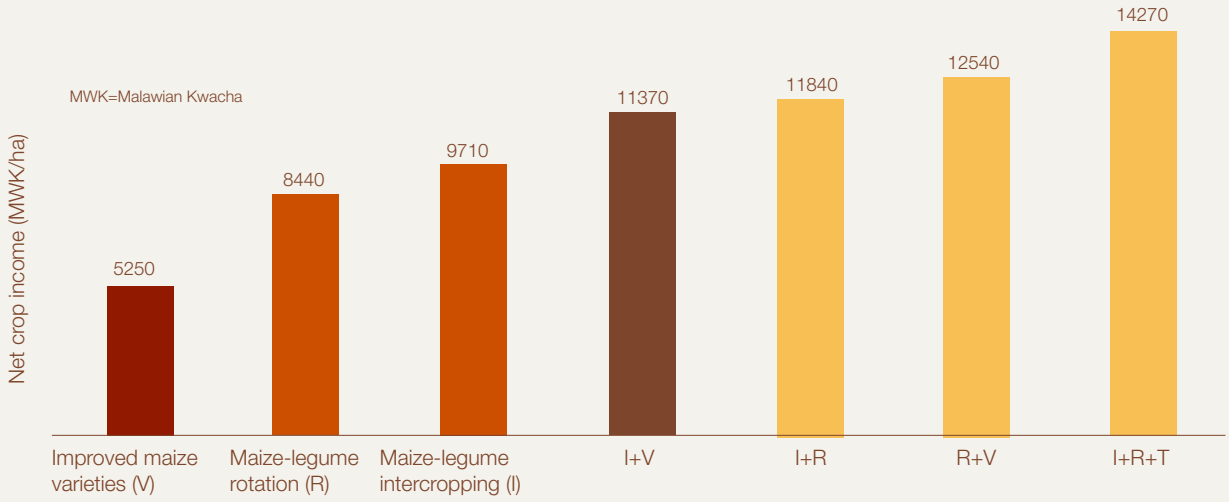



Figure 2: Impact of CA on maize income in Malawi from survey data

# What is the value proposition for society? Impact on ecosystem services

One of the major reasons CA is advocated for is because of its positive impact on ecosystem services such as soil loss mitigation and soil system functioning. Maize–legume intercropping was demonstrated to increase total nitrogen in the preceding year compared to planting sole maize (Figure 3). CA options increased water-use efficiency over time (Figure 4). In Mozambique and Ethiopia the highest water-use efficiency was achieved when CA options were combined with maize–legume intercropping system. The CA options further reduced soil loss by 34-65% (Table 4).

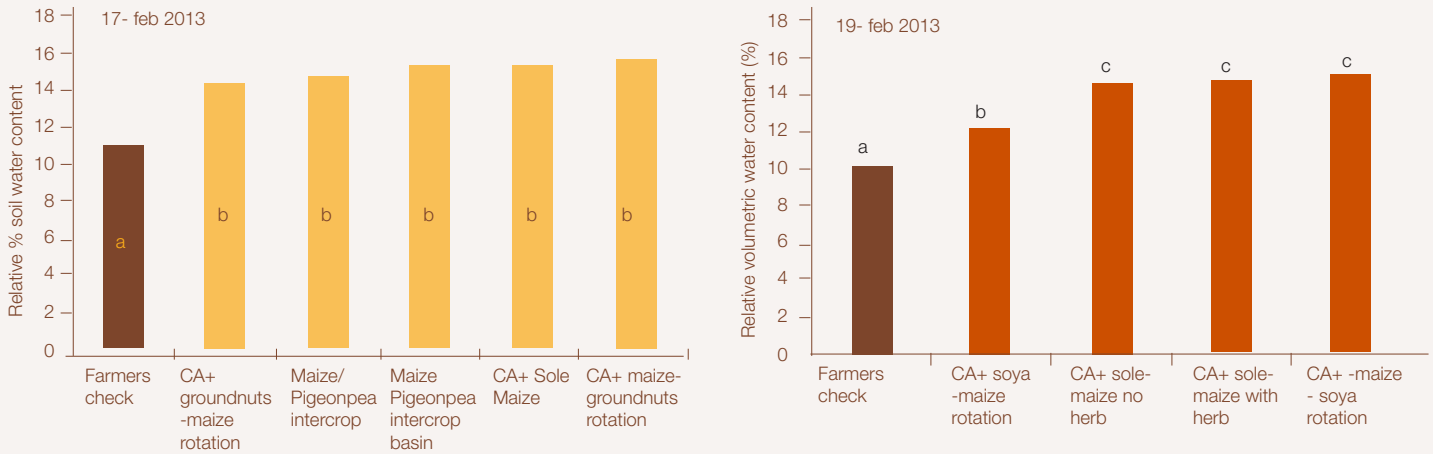



Figure 3: Measured soil moisture effects in lowlands and mid-altitude areas of Malawi in Feb 2013

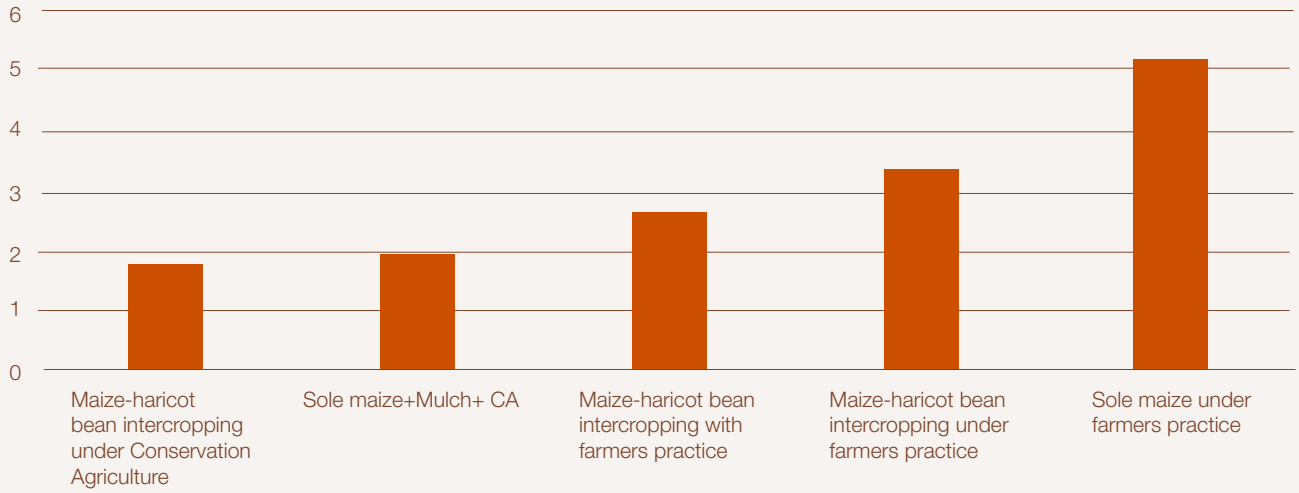



Figure 4: Soil loss measurements under various production options in Ethiopia (tons/ha).

## What about the impact of CA on risk mitigation? Some early results from a risk model

The management of risk (specifically the reduction of downside risk) is an important goal for poor farmers most of whom operate in challenging environments. Risk management and mitigation can be regarded as a goal co-equal to the enhancement of productivity. This is true if it is considered that unmanaged risk is at the core of much of the technological stagnation in African agriculture. The evidence emerging from this research suggests that CA-based practices can reduce risks of crop failure without compromising yields thereby avoiding the classical high-risk, high-return (low-risk, low-return) trade-off (Figure 5). The lower risk premium when minimum tillage and crop diversification are combined suggest that this CA-based option reduces the risk of crop failure, and by implication, the risk premium. From the point of view of smallholder farmers in the eastern and southern Africa region, CA options can serve as risk management strategies, even if formal risk management options were to become available. This is because formal risk management systems would only work where farmers implemented judicious and risk mitigating production systems with only residual risk being transferred to formal risk markets.

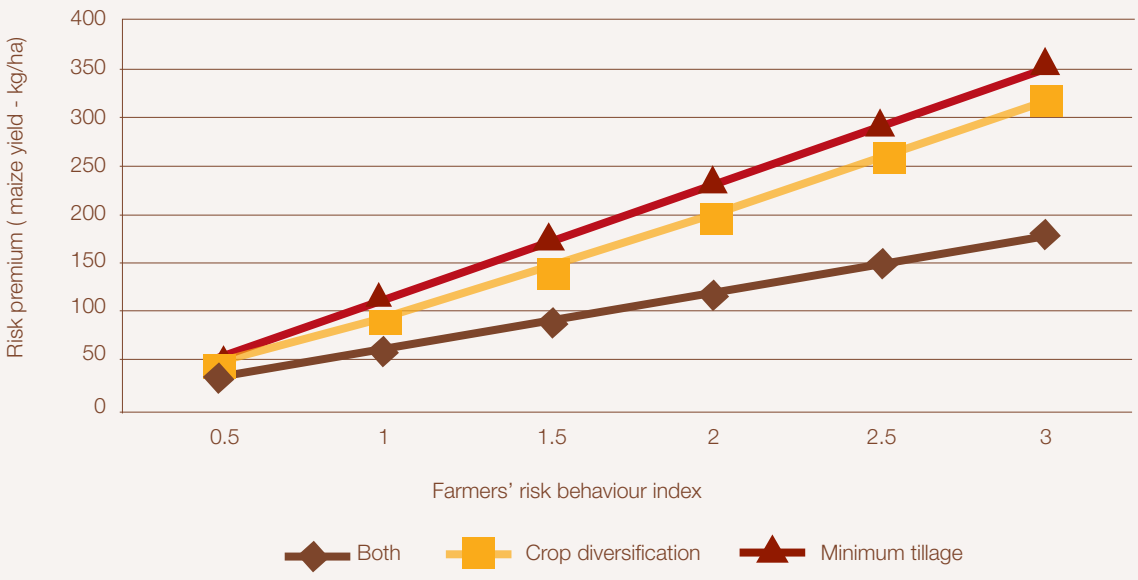



Figure 5: CA options impact on production risk

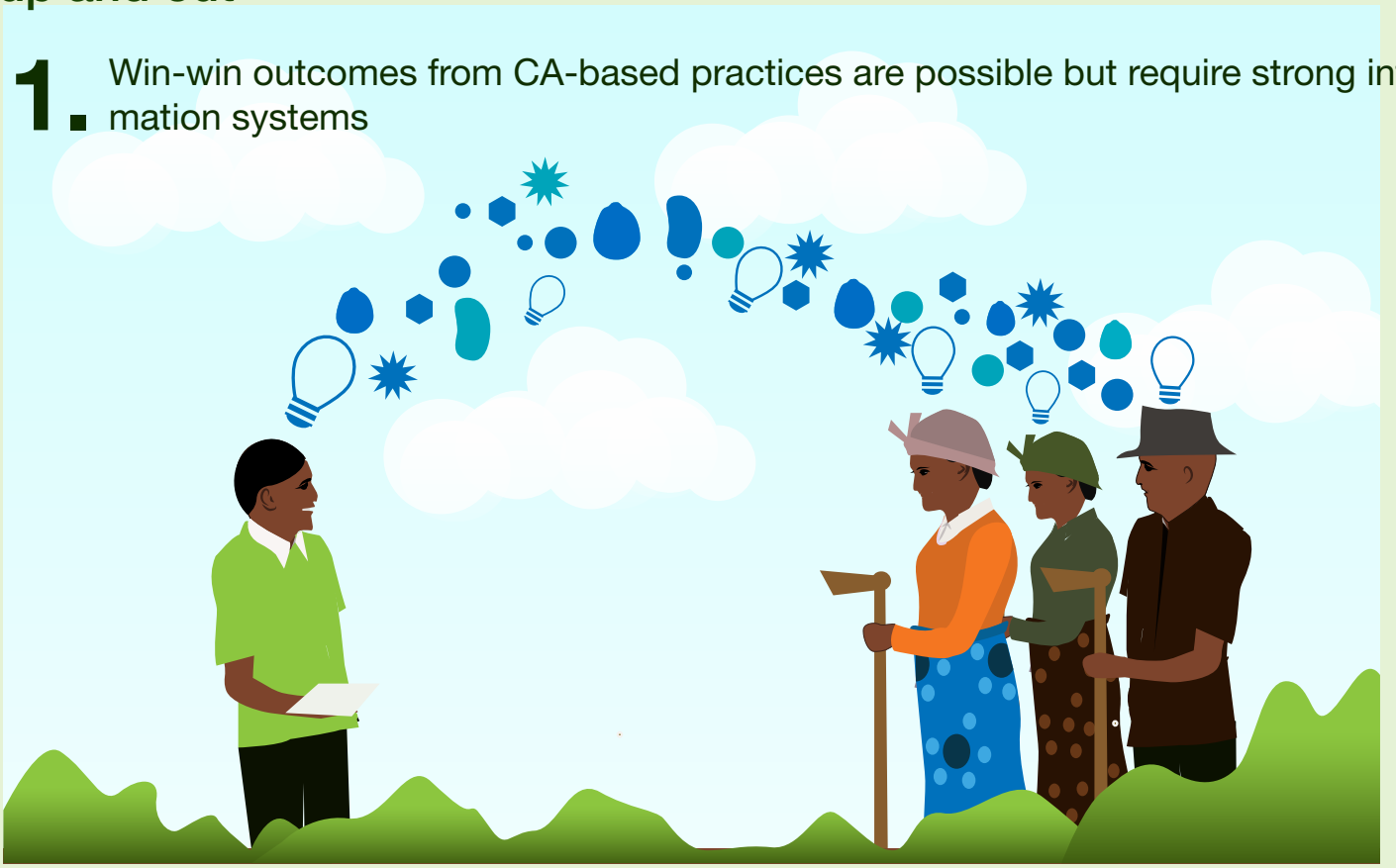
Note: crop diversification refers to maize legume intercropping and rotations

## Can women also benefit from CA-based practices?

The experience from Liganwa farmers' group from Liganwa Village in Siaya County, Kenya, helps to answer the above question. In 2007 an "all women" group was formed with the purpose of helping widows in the community to acquire some capital to engage in micro-businesses. The group's structure was such that they belonged to a rotating credit and savings association (ROCSA) called 'Merry-go round' in Kenya. The group was initially not very successful in their efforts to raise capital for the rounds because some members were unable to pay their contribution. An opportunity came for the group to join SIMLESA in March 2010 as members of an innovation platform. The group learned about SIMLESA project through a son of one member (Christine) who informed them that researchers from the Kenya Agricultural and Livestock Research Organization (KALRO) were looking for a group in Siaya County to participate in a new project on farming. The group later met with KALRO researchers and agreed to experiment with suggested CA practices. After SIMLESA was explained to them, they agreed to experiment with suggested CA practices. The impact of these new practices have been notable. According to Rosemary, the Chairperson of the group, members are now able to sell some surplus maize and earn money, part of which they bring to the group. The amount of money that the group members can now borrow has significantly increased from the initial Kshs 1000 ($10) to between 3,000 ($30) and 5,000 ($50) with 100% repayment rates.

## Where do we go from here? Some messages to inform scaling up and out

### 1. Win-win outcomes from CA-based practices are possible but require strong information systems



The results from CA experiments, on-farm trials and socio-economic analysis clearly show that CA-based practices also reduce costs of production thereby promising win-win outcomes. Though CA-based practices are simple on the surface (legume intercrops, reduced frequency of tillage, residue retention) the challenge is that they are intensive in information and skills. Therefore, the challenge to achieve widespread adoption a strong focus on agricultural extension and information delivery to farmers as well as adaptive research is required. The aim being that of ensuring that as many farmers as possible are informed about these techniques, their benefits and the need for long-term thinking in some cases. In the end, building farmers' knowledge and skills must be an integral part of CA-based sustainable agricultural intensification.

**Simulating the role of formal extension in CA adoption**

In a policy simulation paper involving the five SIMLESA countries to test for the relative importance of extension and expenditure of fertilizer subsidies, the results showed that both input subsidy policies and policies that focus on increased extension personnel had powerful effects on predicting CA adoption at the country level. By increasing extension, the probability of adoption increased even if the simulation assumed complete absence of credit. The implications of these policy simulations are threefold. First, the impact of input subsidies in predicting CA adoption implies that lowering costs of complementary inputs (fertilizers, seeds, herbicides, and equipment) is central in encouraging CA adoption. Considering that subsidies are essentially ways to reduce prices of inputs, diverse options for structurally lowering input-output price ratios should be of paramount policy interest. Second, investing in agricultural extension systems and increasing the number of extension personnel (increasing the extension personnel to farmer ratio in our case) and expanding the reach of publicly funded extension systems among other complimentary providers is a crucial element in the success of CA as was confirmed by the significant predicative power of high density of extension staff per farmer on probability of CA adoption in the policy simulations.

## 2. Accelerating variety selection and release requires building of strong private sector-agri-businesses coalitions


When SIMLESA project was designed, one of the key project outputs was increasing the range of maize and legume varieties suitable for CA based production. Farmer-participatory variety selection (PVS) was used as a novel approach to fast-track the release of varieties needed for maize-legume cropping system intensification. Accordingly, 396 on-farm PVS trials were conducted among SIMLESA target communities in all the five countries between 2010 and 2014. Several of the varieties tested in the SIMLESA project were taken up by seed growers in the respective countries.

The main lesson from the varietal work under SIMLESA is that building on existing work and networks to create multi-stakeholder coalitions (involving international and national researchers, extension departments, farmer groups and seed companies) can have significant results and can hasten the movement of varieties through the Research and Development pipeline and reduce the time-to-market of new varieties.

> The message is that opportunities to build the social capital of farming communities, and formalizing and supporting farmers' groups are important to create networks of information exchange, market access and resource mobilization.

## 3. Social capital, public goods and private assets are co-determinants of adoption of sustainable agricultural intensification practices

Results from adoption models using data from SIMLESA and related projects show that a variety of social capital indicators were important in predicting the adoption of many CA-based and related production practices. In Ethiopia, Kenya and Malawi the results consistently showed that farmers belonging to groups (having some social capital) were more likely to have more diversified cropping patterns. They were also more likely to try new minimum tillage methods, improved maize varieties and build soil and water conservation structures. Moreover, social groups facilitate the participation of women in agricultural innovation process. The message from this is that opportunities to build the social capital of farming communities, and formalizing and supporting farmers' groups is important to create networks of information exchange, market access and resource mobilization. The influence of public goods was found in the strong association between the practice of better practices and the number of contacts adopting farmers had with extension personnel. Similarly a positive association existed between adoption farmers' positive perceptions of the extension personnel working in their villages.

## 4. Markets are key and so are strong agribusiness value chains

Markets are key in enhancing surplus production. Indications are that farmers who were close to markets with better access to input and output markets, were more likely to have adopted diversified cropping patterns involving maize–legume intercrops and rotations, improved varieties and were also more likely to have tried minimum tillage (with all factors constant). Private asset endowments (such as land, equipment, and livestock) were consistently associated with higher probability of adoption of CA-based practices. Thus suggesting that those without these assets are restricted to access liquidity (or credit markets) to finance adoption of CA-based practices while those with these assets are probably able to liquidate some of it to generate the finances for input purchases and other farm investments. Reflecting the fact that most smallholder farmers do not rely on credit markets, asset ownership had the effect of increasing adoption of soil conservation practices, crop diversification, and implementation of minimum tillage. The policy message is that building up systems for financial inclusion is important, and strengthening and protecting the assets of the poor should be central to fostering their agricultural and economic progress.

## Further readings

FAO (Food and Agriculture Organization of the United Nations). 2012. Conservation agriculture. Agriculture and Consumer Protection Department. URL: http://www.fao.org/ag/ca/, accessed December 15, 2012.

Godfray, H. C. J. et al. 2010. Food security: the challenge of feeding 9 billion people. Science 327: 812–818.

Hobbs, P.R., Sayre KD and Gupta, R.K. 2008. The role of conservation agriculture in sustainable agriculture. Philosophical Transactions of Royal Society B (UK) 363: 543-555.

Kassie, M., Teklewold, H., Marenya, P. Jaleta, M. and Erenstein, O. (2015), Production risk and food security under alternative technology choices in Malawi. Application of a multinomial endogenous switching regression. Journal of Agricultural Economics. 66(3): 640-659.

Kassie, M., Teklewold, Jaleta, M., Marenya, P. and Erenstein, O. (2015) Understanding the Adoption of a Portfolio of Sustainable Intensification Practices in Eastern and Southern Africa. Land use Policy (2015) 42:400-411

Marenya, P.P., Kassie, M., Jaleta, M. (2015) Adoption of conservation agriculture under alternative agricultural policy and market access indicators: Evidence from Eastern and Southern Africa. Paper Presented at the 29th International Conference of Agricultural Economists, August 9-14, 2015, Milan Italy. https://www.conftool.com/icae2015/index.php?page=browseSessions&form_session=79.

Teklewold, H., Kassie, M., Shiferaw, B. and Köhlin, G. (2013) Cropping Systems Diversification, Conservation Tillage and Modern Seed Adoption in Ethiopia: Impacts on Household Income, Agrochemical Use and Demand for Labor. Ecological Economics, 93: 85-93.

Royal Society. 2009. Reaping the Benefits. Science and the Sustainable Intensification of Global Agriculture. RS Policy Document 11/09.

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