SIMLESA POLICY BRIEF

Enhancing farmers' resilience to climate change: the strength of Conservation Agriculture for Sustainable Intensification in Tanzania

Executive Summary:

Low productivity of maize-legume cropping systems is the major problem threatening food security and income of farmers in Tanzania. The problem is caused by rainfall variability, soil erosion and use of cultivation practices which are not climate smart. The SIMLESA project has tested and validated a set of conservation agriculture based sustainable intensification (CASI) technologies and practices for specific agro ecologies over the past eight years.Over 50,353 (82.5%) farmers in project sites have adopted these options with tangible benefits including increased yields, reduced drudgery and time saved for other uses, increasedincomes, enhanced social equity, in addition to enhanced soil fertility and better ecological balances in the medium andlong term horizon. The project relied on a range of institutional innovations based on private public partnerships to foster the enabling environment for farm-level adoption of CASI. Given its potential to address economy-wide challenges, we propose that CASI be institutionalized by becoming integrated in the regular program of work of TARI, the national extension system, the Ministry of Agriculture, of maize and legume value chain service providers, development partnersand other players in the agricultural development field.

Required actions include mainstreaming CASI in the national agricultural investment plan as a budgeted program; integrating CASI in the agricultural educational curricular at all levels; revamp the national extension system by funding public-private partnerships inSMS-based climate-smart agro-advisory services, establishing more agricultural innovation platforms in addition to retooling extension workers to enhance their capacities to facilitate actors; making use of competitive grants to catalyze participation of change

introduction to the problem:

The problem.

Maize –legume intercropping is the main cropping system used by farmers in Tanzania covering about 4,036,996 ha and 1,118,406 ha for maize and beans respectively of the total cultivable land (FAO Stat, 2018). However, productivity of the two crops have remained low 1.2 t/ha for Maize and 0.38 ton/ha for legumes (Country Synthesis Report 2018). These yield levels are too low compared to 4.5 tons/ha and 1.4 tons/ha for maize and legumes respectively obtained through CASI technologies.

Causes of current situation:

Major causes for low productivity are drought, floods, low soil fertility, insect's infestation, and diseases. The frequency of bad cropping season mainly due to drought is higher than the favourable weather. Maize yield loss per year due to drought in Tanzania is estimated to be 246,823 tons equivalent to Tshs 126,033,420 (USD55,767,795) and legumes 59,982 tons equivalent to Tshs 90,228,240 (USD39,924,138) (Arce and Caballero, 2015). These losses account for 0.96% and 0.69%of GDP loss for maize and legume respectively.

Soil erosion is another factor which contributes to the yield loss in the country. Soil erosion in the farming industry is caused by intensive farming without following appropriate conservation measures such as CASI.In parts of Kondoa soil loss was estimated to be 14·7, 23 and 15.7 t/ha/year for 1973, 1986 and 2008, while in the Usambara Mountains soil erosion is estimated to vary from 72 t/ha/year to 120 t/ha/year (Lundgren, 1980; Pfeifer, 1990). Furthermore, a soil loss of 28 to 72 t/ha/year was observed in the arable lands on the slopes of Mount Kilimanjaro (Temple, 1972). Between 1966 and 1970soil loss in Uluguru Mountains was estimated to be 312 t/ha/year (Rapp et al., 1973). Degraded land due to erosion store less water, which in turn make crop vulnerable to water stress even in minor drought (COPEC 2013). Soil erosion leads to loss of top fertile soils (reduces soil organic matter and soil depth)and damage agricultural land (Rills and gullies).

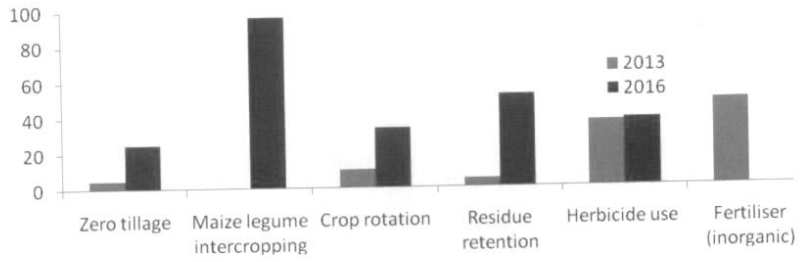
Effects of current situation:

The traditional farming practices has lead into annual loss of fertile soil of 25%, leading to low yields of crop and siltation of water bodies that threaten disappearing of lakes such as of lake Manyara and Eyasi, which are tourism attractions. This has a tremendous negative impact on the tourism industry which is an important source of revenue to the country. Both drought and soil erosion has caused low productivity of maize to an average of 1.2 t/ha and 0.38 t/ha for pigeon pea in traditional farming as compared to average of 4.5t/ha and 1.5 t/ha for maize and pigeonpea respectively under improved farming practices (SIMLESA baseline survey report 2010).Weather variability projections from General Circulation Models reported by Arndt et al.(2012)show that, relative to a no climate change baseline and considering domestic agricultural production as the principal channel of impact, food security in Tanzania appears likely to deteriorate as a consequence of climate change in the next 30 years. Furthermore, it has been shown thatwith increase in temperature and reduced rainfall as well as change in rainfall patterns, average yield of maize in Tanzania will decrease by 33% (0.396 t/ha =from 1.2 t/ha to 0.80 t/ha) country wide. In the central regions maize yield will decrease by up to 84% (1.0 t/ha), 22% (0.264 t/ha) in North-eastern highlands, 17% (0.204) in the Lake Victoria region, and 10 – 15% (0.13t/ha) in the Southern highlands (URT, 2007).

The consequence is persistence food insecurity and poor livelihood of the community. This could be prevented by practicing the available improved technologies such as Conservation Agriculture based Sustainable intensification (CASI).

Research results:

Figure 1: Trend in adoption of CA practices at household level (%) in 2013 and 2016



Source: Adoption Monitoring Surveys, 2013 and 2016

Research undertaken over the last eight years indicates several benefits for farmers who have utilized any or all the combinations of the basket.

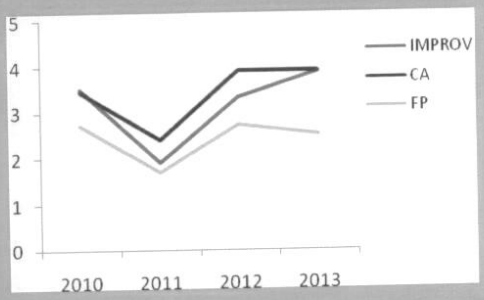
Adoption of CASI increases resilience to climate change effects

CASI technologies and practices improve the soil organic matter content and in turn the soil's moisture retention capacity (Table 1). This leads to higher maize and legume yields even under drought conditions. In 2011, which was a drought year, fields using CASI performed better implying the potential for CASI to lower the risk of yield loss during adverse weather (Fig 1).

Table 1: Soil moisture and organic carbon content under CASI and conventional farming practices measured at crop flowering (4-season average).

Practice	Moisture (%)	Organic matter
Conventional farming	20.69	2.55
CASI	22.23	3.23

Fig 1: Response of different practices in varied seasons in terms of grain yield (t/ha) over 4 years.



Yields increase several-fold when farmers adopt CASI practices

Farmer field level results from eight cropping seasons over a four-year period indicate a substantial increase in yields for farmers who adopt CASI compared to two other farming practices – conventional (CONV) and traditional farming (FP). Yields increased from 0.38 tons/ha to 1.5 tons/ha for pigeon pea (Figure 2) and from 1.2 to 4.5 tons/ha for maize (Figure 3) for farmers practicing CASI compared to non CASI practice.

Fig 2. Average maize yield t/ha for 8 seasons in low (a) and high (b) potential environments in Tanzania.

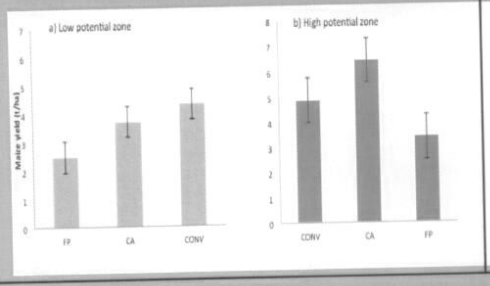
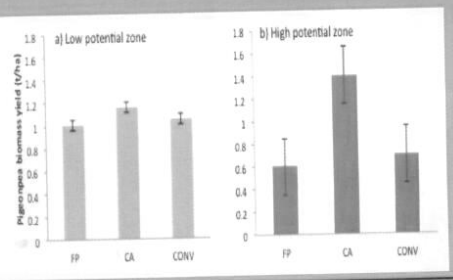


Fig 3. Average legumes yield t/ha for 8 seasons for low (a) and high (b) potential environments in Tanzania



Farmers who adopt CASI face less drudgery and save time for other uses

The combination of use of herbicides for weed control and management and minimum tillage applied in conservation agriculture-based sustainable intensification leads to a total average time spent in the field per season of only 84.7 hours/ha. This is equivalent to only three quarters of the time that farmers using conventional or traditional farming practices spend in the field (Table 2). The total time spent in CASI fields was 21 hours/ha less than the time spent in the field using farmer practices and 28 hours/ha less than for those who used conventional practices. The time saved can be used to expand land under production or for use on other productive activities leading to additional income through income diversifica-

able 2: 4 year average of time saved by using CASI viz a viz other practices (hr/ha)

Practice	Herbicide application (hr/ha)	Ploughing (hr/ha)	Weeding (hr/ha)	Total (hr/ha)	Time saved by using CASI (hr/
Farmers' practice	-	13.6	91.8	105.4	
Conventional farming	-	13.3	100.2	113.5	
CASI	9.9	-	74.9	84.7	28.8 (25%)

CASI is more profitable and therefore has a greater poverty reducing effect

Besides the soil health benefits that accrue into the long-term and the time savings, farmers who practice CASI also obtain a higher profit margin of TShs 4,048,928 equivalent to USD 1,796.33 compared to those who maintain the conventional and or traditional farming practices (Table 3).

Table 3: Average Farm partial budget over 4 years for different practices in different communities in Tanzania

	Conventional	CASI	Farmers' Practice
Total variable costs (USD/ha)	540.625	353.125	343.75
Yield of maize (Mt/ha)	4.5	5.0	2.0
Gross revenue from maize (USD/ha)	1,154	1,315	427.12
Gross revenue from stover (USD/ha)	31.25	62.5	20.5
Yield of Pigeon pea (Mt/ha)	1.6	1.8	0.8
Gross revenue from Pigeon peas (USD/ha)	842.1	947.4	28
Total revenue USD	2,027.35	2,324.9	519.204
Net benefit (USD)	**1,486.73**	**1,971.78**	**175.454**

Therefore, SIMLESA has shown that farmers can increase their resilience to climate induced risks and better their food security and incomes through adhering to the simple principles of conservation agriculture based sustainable intensification.

But what drives adoption at farm level and what is needed to scale up these benefits for all farmers across Tanzania and ensure that impact is sustained beyond the donor-funded phase? SIMLESA validated and tested several institutional innovations involving several public-private partnerships to provide an enabling environment for farm level adoption of CASI.

Networking actors through the Agricultural Innovations Platforms Model

SIMLESA established 10 Agricultural Innovation Platforms (AIPs) (4 in Northern zone and 6 in Eastern zone). AIP membership comprised actors in the maize-legume value chains including farmers, extensionists, agro-dealers, village leaders, religious leaders, school teachers and micro-finance instructions. The AIPs provided a platform for knowledge sharing among actors, for identifying local problems and linking farmers to policy makers for action on those issues, as well as linking buyers and sellers of goods and services. The business to business linkages induce a market pull effect which creates demand for CASI technologies. Through AIPs the project managed to reach 233 directlywith multiple benefits including more gender equity and improved access to markets and services. Extension workers were trained in the

various aspects of CASI and business entrepreneurship and these in turn trained the AIP members. There were also spillover effects as farmers who were not members of AIPs benefited from farmer to farmer interaction with AIP members in their communities. Therefore use of AIPs supported information dissemination and the successful adoption of CASI technologies. The service delivery models developed as part of the AIPS enhanced farmers' access to services at reduced costs while creating job opportunities for the youth engaged as business service providers. *Catalyzing the participation of change agents through a Competitive Grant Scheme*

The project implemented a competitive grant scheme that catalyzed participation of change agents in the civil society and private sector and enhanced the reach of the project beyond what would have been possible if TARI had worked in isolation. *investing in short and long-term training to build a critical mass of researchers and trainers in CASI*

CASI is knowledge intensive at all levels of extension, training and education. To contribute to reducing skills gaps within TARI, ACIAR funded training for 1 PhD and 9 Masters Degrees in breeding, socio-economics, extension, and agronomy and crop protection. CASI guides and manuals were also developed and used in short-term trainings of various actors including scientists, extensionists and farmers. To ensure a critical mass of actors who are aware of CASI, academia should be brought on board and the modules mainstreamed in agricultural educational curricular at all levels.

Building partnership with complementary projects

SIMLESA partnered with FACASI, another ACIAR funded project in order to link CASI farmers to smallholder appropriate mechanization for reduced tillage. Identifying projects that complement ongoing efforts is critical in ensuring synergies and avoiding duplication of efforts and maximizing the impact of development funding.

Policy engagement

In 2015, Tanzania joined the other SIMLESA participating countries in a high level policy forum on CASI. The meeting culminated in a joint declaration in which countries committed to providing an enabling environment for CASI implementation. CASI has already been mainstreamed in the national agricultural investment plans of Malawi and Rwanda and forms a core part of Kenya's climate-smart agriculture strategy. It is imperative that CASI is mainstreamed as a core program in the Tanzania National Agricultural Investment Plan and related national planning and budget instruments in the sector.

Use of multiple scaling-out approaches

The SIMLESA project used multiple approaches to scale out CASI to more farmers in the project sites. These included use of host farmers to demonstrate the technologies at village level, farmer field days, farmer exchange visits, Agricultural Innovation Platforms (AIPs), partnerships with change agents and use of mobile telephony (SMS). These approaches enabled the project to reach a total 61,034 farmers within the project period. Partnerships with change agents in civil society and private sector alone including the local NGO - RECODA, the national farmers' organization - MVITWATA and private seed company – SUBA AGRO increased project coverage from 10 communities in 2010 to 142 communities by 2018 amounting to a total of 48,481 farmers.

Institutionalizing CA-based sustainable intensification in Tanzania's agricultural production system requires investments in a suite of institutional arrangements that should be championed by the Ministry of Agriculture to bring the benefits of CASI to more farmers country wide. Innovations that put farmers closer and in more control of output and input markets for goods and services, that enhance access to market

information and climate smart agro-advisories, and that catalyze private sector investment in value addition and business service provision are needed to take CASI to more farmers. Institutionalizing CASI in the national system will require exploiting synergies in public and private partnerships among farmers, policy makers, researchers, academia, change agents and development partners as has been tested and validated by SIMLESA.

Policy Recommendations:

Given its potential to address economy-wide challenges, we propose that CASI be institutionalized by becoming integrated in the regular program of work of TARI, the national extension systemin the Ministry of Agriculture (MoA) and Local Government Authority (LGA), maize and legume value chain service providers, development partners and other players in the agricultural development field.

Key actions include:

Mainstreaming CASI in the national agricultural investment plan as a budgeted program;

Integrating CASI in the agricultural educational curricular at all levels

Mainstreaming ICT-based climate-smart agro-advisories (especially through use of SMS) and the AIP model in the national extension system in addition to retooling extension workers to enhance their capacities to facilitate actors

Making use of competitive grants to catalyze participation of change agents in scaling out CASI.

Support the establishment of more Agricultural Innovation Platforms (AIPs) and mainstream AIPs in the current model of extension. Include Conservation Agriculture - based Sustainable Intensification practices (CASI) in extension manuals to facilitate wider adoption of the technology package

Include herbicides in the national input support system similar to fertilizer

Create an enabling environment (policies, taxes and licenses) to facilitate the private sector to mass produce and distribute minimum tillage machinery and implements (planters, rippers, maize choppers, etc).

Benefits of Action:

Conservation agriculture such as minimum soil disturbance, intercropping of maize and legumes and soil cover prevent soil erosion, increase moisture infiltration to the soil instead of surface runoff, conserve moisture, increase soil fertility, regulate soil temperature, increase crop yields and yet economical.

What will happen if this problem is not acted on?

Persistency of low productivity due to droughts, flood and soil degradation hence food insecurity and low income to farmers

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