ENHANCING AGRICULTURAL RESILIENCE AND SUSTAINABILITY IN EASTERN AND SOUTHERN AFRICA

Key Findings and Recommendations for Mozambique

Domingos J.B. Dias, Eduardo P. Mulima, Maria da Luz Q. Cadeado, Custodio J.F. Jorge and Jose D. dos Santos Chiocho

IIAM
Instituto de Investigação Agrária de Moçambique

CIMMYT

SIMLESA
Sustainable Intensification of Maize and Legume Systems for Food Security in Eastern and Southern Africa

Australian Government
Australian Centre for International Agricultural Research

Contents

List of Figures

List of Tables

List of Acronyms

ACIAR	Australian Centre for International Agricultural Research
AIP(s)	agricultural innovation platform(s)
CASI	conservation agriculture-based sustainable intensification
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IIAM	National Agricultural Research Institute (Mozambique)
ILRI	International Livestock Research Institute
ISPM	Instituto Superior Politécnico de Manica [Polytechnic Institute of Manica]
NGO(s)	nongovernmental organizations
QAAFI	Queensland Alliance for Agriculture and Food Innovation, University of Queensland (Australia)
SIMLESA	Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa

AGRICULTURE IN MOZAMBIQUE

Agriculture is a key pillar of economic growth in Mozambique. The sector employs more than 80 percent of the country's labor force and contributes 24 percent of gross domestic product [1]. Nearly 90 percent of the foods grown domestically are produced by smallholder farmers.

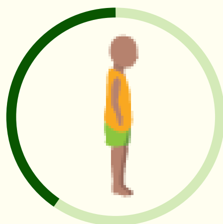
Given numerous challenges to economic growth, such as poor access to health services, high malnutrition rates are common and persistent in rural areas. Approximately 42 percent of children are stunted, and 25 percent of the households are vulnerable to severe food insecurity.

Climate change and variability present major challenges to agricultural production and rural livelihoods in central Mozambique. The World Bank [2] ranked Mozambique third among countries under extreme risk of climate change impacts in Africa. The higher frequency of climate-related hazards, such as drought, flooding and in-season dry spells, is already having a devastating and cumulative impact on agriculture, and the population is insufficiently prepared [3].

Agriculture is mainly rainfed and is highly dependent on natural resources. Yields of maize, soybeans, groundnuts and common beans are projected to decline by 1–25 percent due to higher temperatures, rainfall variability and the delayed onset of the season in this region. More than 75 percent of the smallholder farmers cannot afford to invest in advanced agricultural technologies. Pervasive high poverty and low literacy levels limit people's options for making agricultural activities more climate-resilient or for finding alternative livelihoods.

The sector employs more than
80%
of the country's labor force

It contributes
24%
of gross domestic product



Approximately
42%
of children are stunted

25%
of the households are vulnerable to severe food insecurity

A New Approach to Agriculture

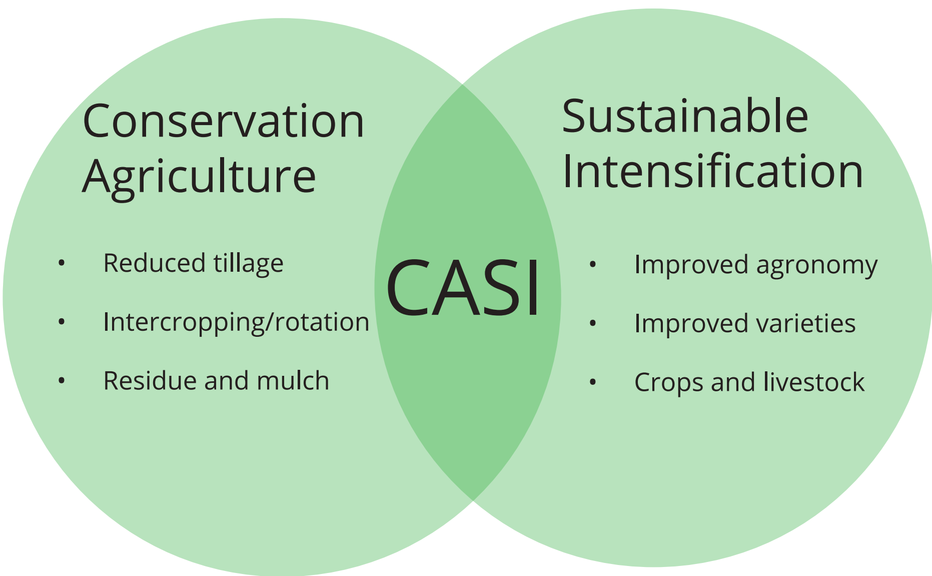
Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA) was a project implemented between 2010 and 2018 in five African countries (Ethiopia, Kenya, Malawi, Mozambique and Tanzania) and two spillover countries (Rwanda and Uganda). The project's goal was to increase African smallholders' food security, productivity and income levels by integrating sustainable intensification practices to increase productivity, while simultaneously protecting the natural resource base. The particular mix of technologies developed by SIMLESA are known as "conservation agriculture-based sustainable intensification," or CASI (Fig. 1). By utilizing these technologies, SIMLESA sought the dual outcomes of sustainably raising yields by 30 percent, while decreasing the risk of crop failure by 30 percent. In short, SIMLESA focused on and promoted maize and legume cropping systems to improve food and income security and resilience to climate change on African farms.

The project — financed by the Australian Centre for International Agricultural Research (ACIAR) — was led by the International Maize and Wheat Improvement Center (CIMMYT) in collaboration with numerous partners, including national agricultural research institutes (NARIs), in this case, the National Agricultural Research Institute (IIAM); CGIAR centers, such as the International Center for Tropical Agriculture (CIAT), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and the International Livestock Research Institute (ILRI); and the Queenland Alliance for Agriculture and Food Innovation (QAAFI) of the University of Queensland, Australia.

Project Overview

SIMLESA undertook onfarm research in different agro-ecological zones to assess the benefits of conservation agriculture-based sustainable intensification and to develop appropriate technology packages for smallholder farmers. The project succeeded in increasing the range of maize, legume and fodder/forage varieties available, and involved farmers in seed-selection trials so they could identify their preferences. SIMLESA helped establish agricultural innovation platforms (AIPs) to progress members — including farmers, seed producers, agro-input dealers, nongovernmental organizations (NGOs) and extension workers — along the value chain. The platforms serve farming communities, help mobilize resources, and support up- and out-scaling. SIMLESA also provided training and capacity strengthening for national agricultural research systems and worked with government, business and civil society organizations to provide an enabling environment for the benefits of the newly introduced technologies to be realized by farmers.

Figure 1. Conservation agriculture based on sustainable intensification



Source: SIMLESA-Mozambique.

Note: Improved agronomy includes the use of fertilizer and herbicide; crops and livestock include fodder and forage.

SIMLESA-Mozambique

Cassava and maize are Mozambique's primary staple crops. Sorghum, millet, rice and beans also contribute to household-level food security. Unfortunately, farmers are still growing local low-yielding varieties that are susceptible to the adverse effects of climate change. Maize productivity in Mozambique is around 800 kilograms per hectare — less than half the average for southern Africa. Agricultural value chains are only in their early stages of development due to challenges relating to production, product quality, lack of functional markets and lack of access to financial services and credit [4]. Additional problems involve low investment in the sector and competition with imported goods. Producers face many constraints to marketing their products, with the most frequent being lack of traders, long distances to markets, lack of transport and low prices [5].

Mozambique's agricultural sector is generally characterized by lower yields and input use compared with its regional neighbors, and greater probability of extreme climate events, such as drought, flooding and cyclones. In response, local policy-makers and agricultural specialists have expressed interest in exploring the potential for conservation agriculture to improve smallholder productivity and decrease vulnerability to climate change. Although conservation agriculture has been promoted in Mozambique since 1996, data supporting it impact in terms of yield increases remain limited.

Strategic Approach

SIMLESA-Mozambique's approach to promoting CASI practices included the following strategic components:

1

Building public and private partnerships to scale CASI practices

2

Initiating policy discussions and networking among different actors in the technology value chain

3

Empowering the national agricultural research system to implement and manage project outputs and share experiences with other organizations working in the project sites

4

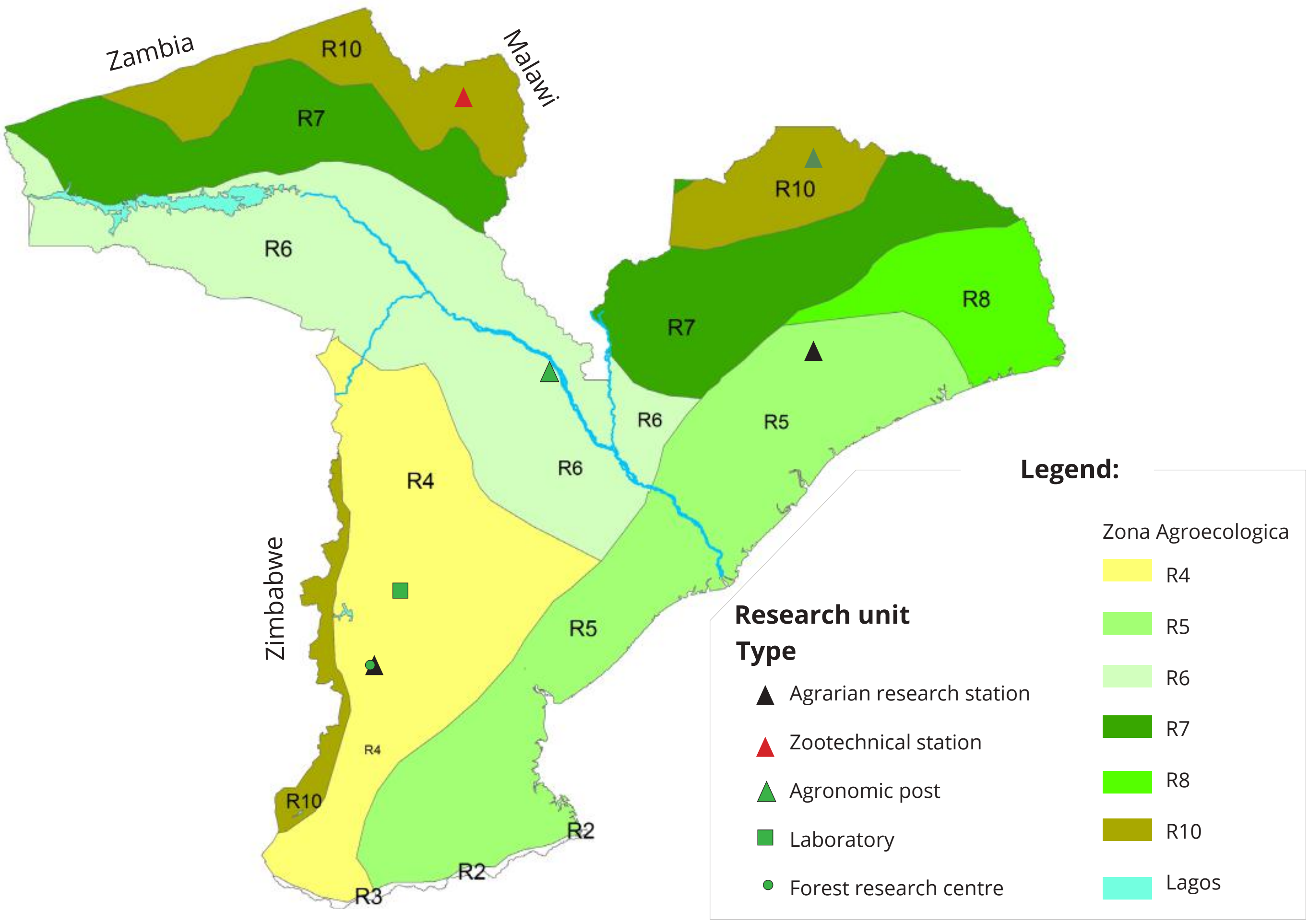
Building farmers' capacity to implement CASI practices through farmers' exchange visits, extension services, training, and the development of existing AIPs

Project Sites

SIMLESA-Mozambique implemented its activities in six communities within two agroecological zones of central Mozambique (Fig. 2). Soils in the low potential areas, Sussundenga and Gorongosa, are medium textured and generally well drained (Fig. 3). The cropping system is dominated by cereals and legumes, particularly Maize and sorghum. Legumes grown include cowpeas, groundnuts, pigeon peas and (more recently) soybeans. Yearly precipitation varies from 1,000 to 1,200 mm, mainly between November and March. The average temperature is 26.5°C. In the high potential areas — Manica, Rotanda, Ciphole and Cabango in Angónia (Fig. 3) — soils are red clay and ferralitic soils from plateaus. Maize and common beans dominate, along with soybeans and potatoes. Total rainfall is 1,400–1,800 millimeters per year, and average temperatures range from 15 to 22°C. In general, soils are productive, but nitrogen levels in the arable soils are very low.

These sites were chosen because IIAM operates strong research programs and trials focusing on maize and legumes in these locations. SIMLESA-Mozambique operated in three provinces and nine districts totaling an area of 1.65 million hectares.

Figure 2. Agroecological zones of central Mozambique and Research Units-IIAM

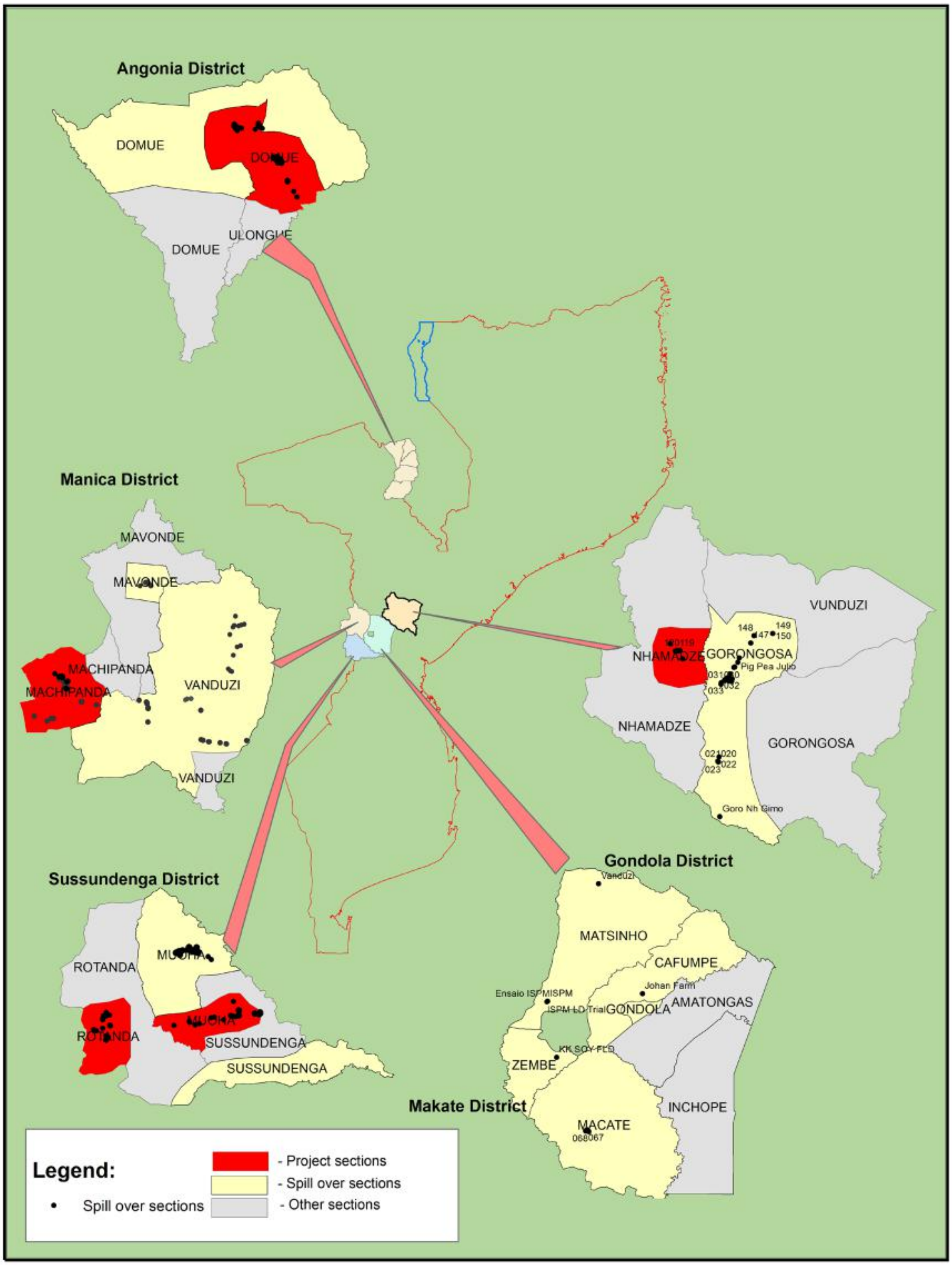


Characteristics of the Zones

Region	Precipitation	Climate	Soil
R4	1000-1200	Semi-humid, semi-humid arid	Ferralsoils and luvisoils
R5	1000-1400	Semi-humid arid, humid	Fluxisoils and arrenosoils
R6	400-600	Semi-dry arid	Lixisoils and fluvisoils
R7	1000-1200	Semi-arid humid, sub-humid	Ferralsoils, luvisoils and acrisoils
R8	800-1200	Semi-arid humid, semi-dry arid	Ferric arrenosoils
R10	1400-1800	Tropical altitude	Reddish clay loam and slender

Source: SIMLESA-Mozambique.

Figure 3. SIMLESA-Mozambique sites



Source: SIMLESA-Mozambique.

Partners

As previously mentioned, SIMLESA-Mozambique worked in close collaboration with the national agricultural research institute, IIAM, and with Instituto Superior Politécnico de Manica (ISPM) [the Polytechnic Institute of Manica], the country's extension network and farmers who hosted trials of CASI practices over an eight-year period. Important additional partners included numerous small seed companies (Dengo Comercial, NzaraYapera, Semente Perfeita and Kleinn Karro), the Manica Farmers' Union, the Manica Development Agency, the Initiative for Agricultural Development in Africa, the project "Tropical Legumes II" and CIAT.

KEY FINDINGS

This section summarizes SIMLESA-Mozambique's key cross-cutting research findings in the context of the following questions:

How can CASI increase the farm-level food security, crop yields and incomes of smallholder farmers?

In what ways do CASI approaches contribute to increasing the resilience of farming systems, protecting the natural resource base and mitigating the risks associated with climate change?

What key factors in terms of government policies, agricultural programs, rural institutions or market arrangements would enable the diffusion of CASI methods among farmers?

Does CASI contribute to a balanced approach to agricultural progress for both men and women, and how might resource-poor farmers — in particular — benefit from these technologies?

What market enhancements, including seed systems and value chains, are needed to encourage the adoption of CASI practices?

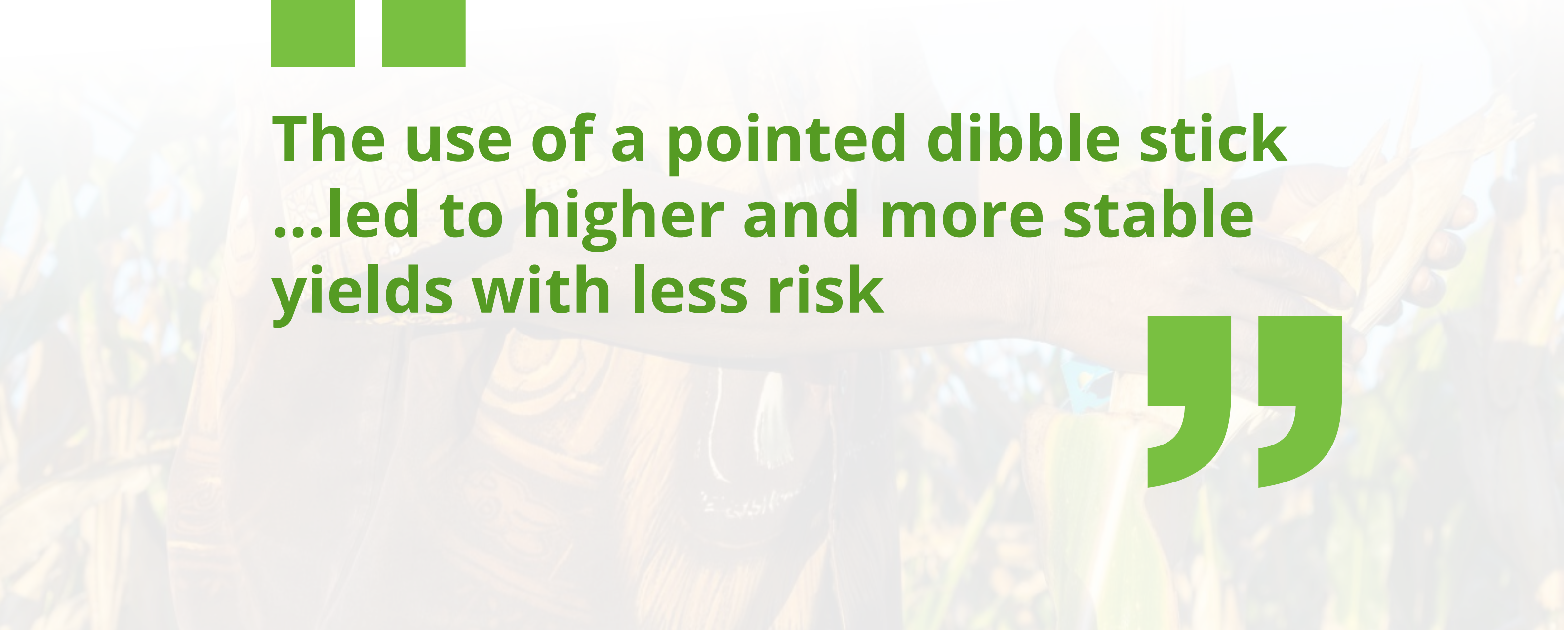
The project's findings were complex. The new approach works by integrating multiple technologies with synergistic effects over different time horizons. In addition, CASI was purposively implemented across a range of agroecologies, which makes it challenging to directly compare results from one region to another. Other challenges included erratic rainfall distribution resulting in the poor performance of some trials; maize pests and diseases, such as outbreaks of fall armyworms inadequate parental materials for seed production and unreliable irrigation. The key findings that emerged are described below.

Farm-Level Food Security, Productivity and Incomes of Smallholder Farmers

CASI practices increased maize, cowpea, and soybean yields by 37, 33 and 50 percent, respectively, in the low-potential areas and maize yields by 46 percent in the high-potential areas. Maize yields were found to be strongly dependent on good agronomic practices, such as improved varieties, improved plant populations and fertilization. The addition of mechanization and herbicides enabled higher maize yields by facilitating timely scheduling of operations and labor savings. In addition to the long-term ecological benefits, CASI practices are attractive to farmers because of their short-term input savings, particularly in terms of the cost of labor and fertilizer. In manual (hoe-based) systems, dibble stick planting (see more below) allows significant labor savings compared with conventional soil banking.[1]

Resilience, Risk Mitigation and Protecting Natural Resources

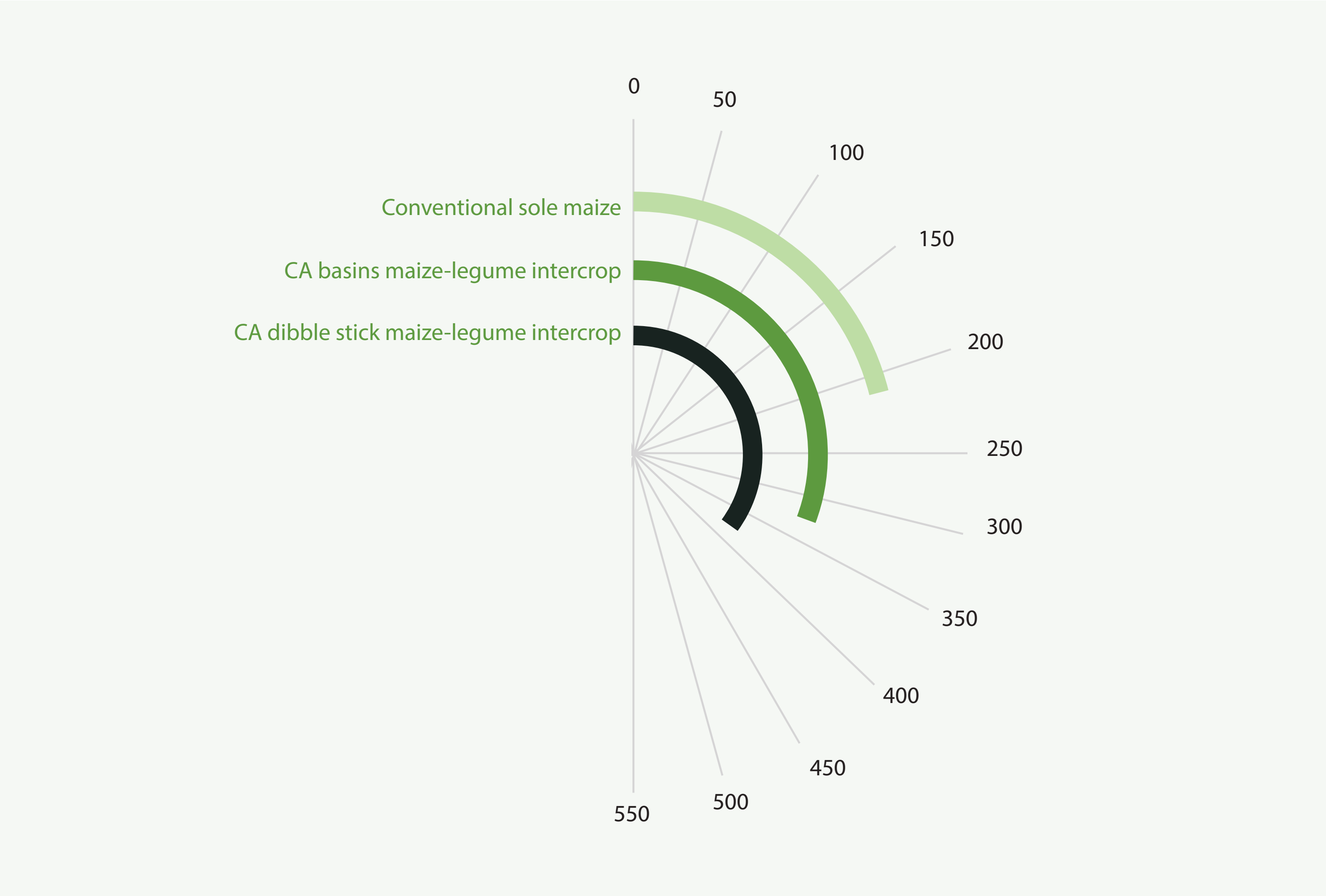
Under conventional methods in Mozambique, seed is planted using a ridge and furrow system constructed with hand hoes. For intercropped maize and cowpeas in the low-potential areas, the use of a pointed dibble stick to create holes where seed can be manually sown and fertilizer applied led to higher and more stable yields with less risk. The net benefits accrued both from higher yields (and hence profitability) and reduced labor costs (Fig. 4). Similarly, in a maize-soybean rotation, the use of a dibble stick for planting in the high-potential areas returned higher and more stable yields with less risk.



"The use of a pointed dibble stick ...led to higher and more stable yields with less risk"

[1]In central Mozambique livestock is integrated into maize-legume intercropping systems, contributing additional household income, draft animal power, organic manure, a means of transportation and additional dietary needs. Competition for crop residues is not a constraint because grazing areas for livestock are plentiful.

Figure 4. Average net benefits of growing maize in high-potential areas using conservation agriculture practices compared with conventional methods (six-year average)



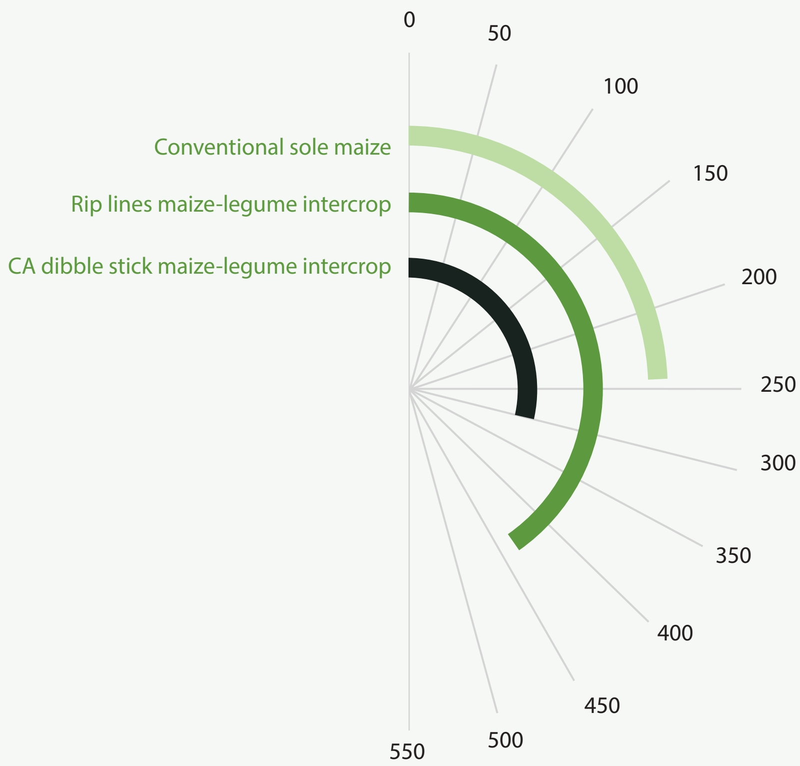
Source: SIMLESA-Mozambique.

The benefits of conservation agriculture practices are most apparent in mitigating the risk of crop failure. This is indicated by the higher net benefits of sowing maize using seeders in the low-potential areas as opposed to sowing following complete tillage under conventional practices. In the high-potential areas, intercropping maize and legumes under conservation agriculture led to higher soil-moisture levels, thereby increasing productivity compared with growing maize only. The CASI practice of digging permanent planting basins is not appropriate for the high-potential areas because under those conditions it causes waterlogging. On well-drained soils in low-potential areas, however, the basins significantly increase yields by conserving water. For this reason, permanent planting basins need to be targeted for use in environments that are prone to dry spells but have well-drained soils.

CASI technologies can be especially beneficial for smallholders with limited capital resources, but it is critical that all farmers be made aware of the short-term time lags associated with using the new approaches before productivity and income benefits accrue. Short-term time lags usually arise because it takes farmers time to learn and adjust to the new methods. Also, the need for weeding and herbicides can initially increase input costs.

Under mechanized systems or those employing draft animal power, the practice of using of rip lines led to higher net benefits in a maize-legume rotation in the low-potential areas compared with conventional methods (Fig. 5). Rip lines break the soil to a depth of only 5–12 centimeters to enable direct seeding, causing minimal disturbance to the soil surface compared with conventional practices.

Figure 5. Average net benefits of growing maize in low-potential areas using conservation agriculture practices compared with conventional methods (six-year average)



Source: SIMLESA-Mozambique.

Gender and Equity

Smallholder farmers in Mozambique primarily rely on their family members to provide farm labor. Female-headed households can be at a disadvantage when it comes to the availability of family labor, making the need for hired labor more likely. As a result, the labor-saving benefits of conservation agriculture are potentially even higher for women. In the high-potential areas of Mozambique, the use of conservation agriculture practices reduced the labor requirement by 15–27 person-days per hectare across seasons compared with conventional methods. In the low-potential areas, the equivalent labor reduction 16–28 person-days per hectare [6].

ACHIEVEMENTS

Farmer Reach and Adoption

SIMLESA-Mozambique commissioned three partner organizations to scale its activities during 2016–2018: ISPM, UCAMA and AgriMerc. In one year (October 2016–October 2017), the three organizations collectively reached 60,083 farmers. As of 2013, about 22 percent of the smallholders reached had adopted at least one CASI practice in the northern region of Mozambique, and this had increased to 47 percent as of 2016. In the central region, rates of adoption of at least one CASI technology rose from about 24 percent in 2013 to about 62 percent in 2016. The most adopted practices were maize-legume intercropping (27 percent), mulching using crop residues (26 percent), and crop rotation (21 percent) (Fig. 6). SIMLESA-Mozambique's partners established six AIPs during 2012–2013, and 46 percent of members were female.

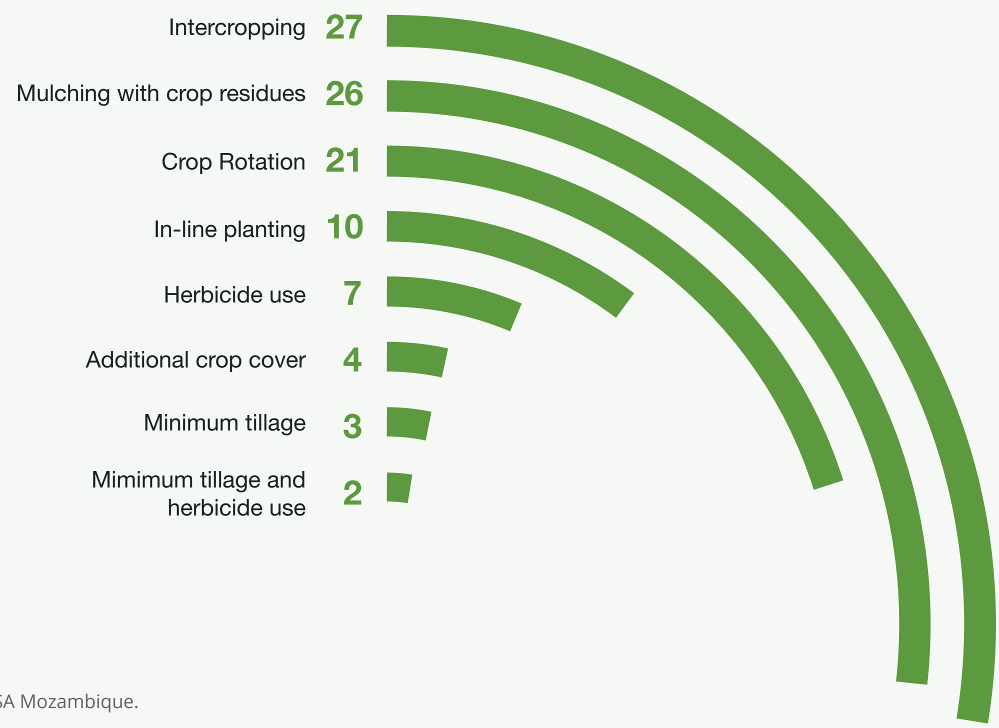
The most adopted practices

27%	26%	21%
Maize-legume intercropping	Mulching using crop residues	Crop rotation

Increase in the rate of adoption of at least one CASI technology

Central Region			Northern Region		
24% in 2013	to	62% in 2016	22% in 2013	to	47% in 2016

Figure 6. Adoption rates, 2017



Source: SIMLESA Mozambique.

OPPORTUNITIES FOR INTEGRATING THE NEW APPROACHES INTO MAIZE FARMING SYSTEMS

Packages for Farmers

Recommendations for farmers vary depending on the agroecological context and available resources. Technologies form "a basket" from which farmers can choose depending on their socioeconomic and biophysical environment. Prescriptions can be fully adopted or farmers can select the combinations they deem most suitable to their circumstances. In addition, the use of good agricultural practices is key to success. SIMLESA-Mozambique identified the following as key factors supporting the adoption of the new technologies by farmers:

1. Improved cash inflow due to increased crop diversification
2. Higher yields from improved soil fertility — partly due maize-legume intercropping and rotations — and water conservation
3. Labor savings from reduced tillage and increased herbicide use (requiring less manual weeding)

Based on these findings, a number of packages are proposed for the agroecological contexts in which SIMLESA-Mozambique operated (Tab. 1).

Table 1. Summary of CASI options for two of Mozambique's agroecological zones

	Low-potential areas		High-potential areas	
	Low inputs	High inputs	Low inputs	High inputs
Type of agricultural practice				
Conservation agriculture				
Reduced tillage	Dibble sticks, permanent planting basins	Small tractors, rip lines, draft animal power	Dibble sticks, permanent planting basins	Small tractors
Crop diversity	Intercropping/ rotations	Intercropping/ rotations	Intercropping	Intercropping/ rotations
Mulching	Crop residues	Live mulch (forage crops	Crop residues	Live mulch (forage crops)
Sustainable Intensification				
Plant density	Increase	Increase	Increase	Increase
Shallow weeding	Timely manual weeding	Timely weeding using herbicide/ weedicide	Timely manual weeding	Timely manual weeding or herbicide use
Fertilizer	Organic	Inorganic	Organic	Inorganic
Herbicide for weed control	Judicious use of herbicide	Judicious use of herbicide		Judicious use of herbicide
Improved varieties				
Maize	Open-pollinated varieties	Hybrid varieties	Hybrid varieties	Hybrid varieties
Maize	Drought-tolerant varieties	Drought-tolerant varieties	Drought-tolerant varieties	Drought-tolerant varieties
Legumes	Cowpeas, groundnuts, common beans	Soybeans, common beans	Pigeon peas, cowpeas, common beans	Soybeans, common beans
Forage		Mucuna, lab lab sunhemp		Mucuna, lab lab sunhemp

Source: SIMLESA Mozambique.

Low-Potential Areas

Areas requiring low resource investment. These farmers have low incomes and are food-insecure. Their main goal is to ensure adequate food production. Given the small size of farms, labor may not be a constraint for families with plenty of members involved in farm activities. The practices recommended under these circumstances include the following:

Reducing tillage using permanent planting basins on well-drained soils, which significantly increases yields and conserves water

Intercropping maize and legume where land area is limited, and rotating maize and legumes where land is relatively abundant

Mulching using crop residues

Using drought-tolerant maize varieties or — where farmers' purchasing power is low — open-pollinated varieties, which also enable farmers to diversify into other food crops, such as cassava and sweet potatoes

Areas requiring high resource investment. These farmers are mostly constrained by climate risk. They have enough land, labor and financial resources, so can afford to pay for agricultural inputs and equipment. These farmers are more commercially oriented, so the goal is to increase household income. Key options highlighted for this group include the following:

Adopting maize-legume intercropping where land is limited, and maize-legume rotation where land is relatively abundant

Intensifying and diversifying into crops with high market value and demand, such as soybeans and sesame

Using live mulch in the form of forage crops

High-Potential Areas

Areas requiring low resource investment. These groups of farmers are vulnerable to food insecurity due to low income levels and smaller land holdings. Investment in legume seeds can have great potential to increase yields and soil nitrogen. Under these circumstances, the recommended practices are as follows:

Using hybrid and drought-tolerant varieties of maize combined with improved legume varieties

Intercropping if land holdings are small and there is a need for low levels of labor

Mulching using leaving residue on the field to be used as mulch, instead of burning it

Areas requiring high resource investment. These farmers have more land and financial resources to invest in inputs and equipment. Key options highlighted for this group include the following:

Intensifying and diversifying into high-value crops and legumes, optionally using drought-tolerant varieties

Reducing tillage using small tractors to help cut farmers' production costs

Intercropping maize and legumes where land is limited, and rotating maize and legumes where land is relatively abundant

Factors Preventing Widespread Adoption of CASI Technologies

Farmers face several constraints to adopting the new approaches, as described below.

High input costs. High input costs (for seed and agrochemicals) were the biggest impediment for farmers.

Lack of availability of inputs. In some cropping seasons, poor availability of new seed varieties, herbicides, and basic conservation agriculture equipment presented a constraint.

Low inorganic fertilizer use. Demand for and use of inorganic fertilizer by farmers is limited due to high costs and lack of information on how to use inorganic fertilizer effectively.

Lack of information on markets and prices. Farmers lack knowledge on output markets and prices for maize and legumes, and are also constrained by their inability to store grain for longer periods in order benefit from seasonal price changes.

In addition to these constraints, in the broader context, appropriate policies, programs and other interventions are instrumental in creating the environment and structures to enable farmers to adopt new approaches in the long term and become integrated into value chains. This involves both discrete and collaborative efforts by government, private enterprise and civil society organizations. The following interventions or enhancements are recommended to support the adoption of the new technologies by farmers.

Training and Capacity Strengthening

Extension. Extension services should support linkages to input supply and markets, interact more with AIPs and provide assistance to households on preparing fields and sowing seed under the new approaches.

Markets and Value Chains

Input markets. Connections between suppliers of fertilizer, seed and equipment (such as maize threshers and hermetic storage bags) and households adopting the new approaches are necessary to allow timely input purchases. This requires strategic sharing of market information with households at times when input use is most effective during the growing season. Agro-dealers need to be trained, linked with input suppliers and supported in distributing inputs through rural agro-dealers and village-based advisors. To improve value chains for maize and legume inputs, farmers need to be educated on improved seed varieties and fertilizers, and agro-dealers need to be supported in expanding their businesses. These two goals can be interlinked as strategic objectives in the promotion or use of improved seed varieties by smallholders.

Output markets. Farmers' organizations, associations and cooperatives provide opportunities for greater bargaining power in the marketing of maize and legumes, including access to improved local and regional markets.

Infrastructure. Poor road infrastructure in rural areas continues to be a significant issue affecting agricultural development generally, but specifically affecting access to markets, which are often at significant distance from villages.

Multisectoral and Social Innovations

Agricultural innovation platforms. AIPs were instrumental in expanding the awareness and adoption of the new practices, and of linking farmers to local and regional output markets. Importantly, the AIPs prompted a significant increase in the participation of women in value chains for maize and legumes.

Civil society and nongovernment organizations. These organizations could participate in scaling the adoption of CASI practices by promoting producer associations and cooperatives and by promoting training and education. Some NGOs can participate in co-funding the scaling out and up strategies and activities as exemplified by NGOs. Synergies should be exploited with projects funded by the Alliance for a Green Revolution in Africa.

Farmer and social groups. Farmers need to be more fully engaged in social networks, so they can share experience of and evidence on available technologies and market information. Actors such as Village Based Agents (VBAs) facilitate the organization of farmers into production groups, training them on operating their farm as a business, and linking them with produce buyers through structured markets. As previously mentioned, organizing farmers into marketing associations or cooperatives provides opportunities for greater bargaining power in marketing maize and accessing improved local and regional markets.

Gender, Youth and Equity

Gender issues. The CASI practices support women's participation in both subsistence and commercial farming activities by providing low-cost and low-labor approaches. As previously mentioned, AIPS have also supported the participation and empowerment of women in maize and legume value chains by providing opportunities for networking, information sharing, and education.

Youth. Mozambique's youth have a positive attitude to agriculture and farming as a primary source of livelihood [7]. Opportunities exist to further expand the adoption of CASI practices by targeting youth in future interventions, strengthening their participation in AIPs, and taking advantage of their use of communications technology.

Successes to Date

1

Based on SIMLESA-Mozambique's AIP experience, the seed and fertilizer platforms cooperated in bringing value-chain actors together to facilitate dialogue and determine solutions to constraints.

2

SIMLESA-Mozambique's development of AIPs with multiple organizations and partners created synergies among related sustainable land management projects and CASI-based development projects.

3

The World Bank–funded Agricultural Productivity Program for Southern Africa, managed by IIAM, built on SIMLESA-Mozambique's experiences .

A SUSTAINABLE FUTURE FOR FARMING AND FOOD SYSTEMS

Scaling the New Approaches

Maize is the second most-important staple food in Mozambique after cassava. Its production is mainly concentrated in the central and northern region, and the vast majority is produced by small-scale farmers in the provinces of Zambézia, Nampula, Niassa, Manica and Tete [3]. Maize, cassava and cowpeas are the most common food crops; they are cultivated by 79, 73 and 50 percent of the smallholder farmers, respectively. Of 84 maize-producing districts, 20 are "highly prone to drought"; 25, to flooding; and another 5 to both drought and flooding [3]. Overall, 48.2 percent of smallholders are prone to one or both risks. CASI technologies provide solutions in these maize-producing districts that are prone climate shocks.

COMMON FOOD CROPS CULTIVATED AND THE SHARE OF FARMERS CULTIVATING THEM

79%	73%	50%
Maize	Cassava	Cowpeas

WHAT IS AT STAKE?

Productivity can only be maintained with increasing inputs, fertilizers and irrigation systems, so if CASI approaches are not scaled in Mozambique, production costs will rise. Failure to implement these new approaches will exacerbate water scarcity and soil erosion. CASI practices support stable yields, lower production costs, reduce the need for labor, and lower the risk of crop failure. CASI methods offer numerous potential benefits in Mozambique, particularly in the plateaus where soil erosion and deforestation are vast. CASI practices provide great opportunities for increasing yields and saving moisture, particularly in low-potential areas and under conditions such as the El-Niño effect, which reduces water availability and crop yields. CASI practices improve farmers' knowledge of sustainable cultivation, promote agroforestry activities to reclaim degraded land, retain soil, and improve soil fertility. Overall, the use of conservation agriculture and adoption of best practices in maize cropping systems has tremendous potential to increase crop yields, support smallholder livelihoods, reduce agricultural risk, facilitate adaptation to climate change, and contribute to environmental sustainability. It also has the potential to contribute to social and gender equity in Mozambique, and most importantly to the country's food security.

CONCLUSION

SIMLESA-Mozambique introduced several CASI technologies, including permanent planting basins, jap platers, small tractors, and improved seed and fertilizer use. Combined, these technologies helped farmers bridge the yield gap and reduce labor and other costs, directly contributing to household food and nutrition security and alleviating rural poverty. SIMLESA-Mozambique undertook trials and demonstrations in many communities in the country's central region. Results showed that a combination of different CASI practices enhanced yields and improved resource use. CASI therefore offers a package of options that combines the principles of conservation agriculture with complementary methods, such as the use of special equipment to minimize soil disturbance, mechanization to reduce labor, year-round soil cover, stress-tolerant crop varieties, timely planting schedules, crop diversification, and water management.

REFERENCES AND FURTHER READINGS

1. USAID (United States Agency for International Development). (2017) Agriculture and Food Security Fact Sheet 2017. Semester 2, Washington, DC.

2. World Bank. 2016. The World Bank Annual Report 2016. Washington, DC. World Bank. https://openknowledge.worldbank.org/handle/10986/24985 License: CC BY-NC-ND 3.0 IGO.

3. MER (Netherlands Commission for Environmental Assessment, Dutch Sustainability Unit). (2015) Climate change profile Mozambique. (Accessed November 17, 2018). https://ees.kuleuven.be/klimos/toolkit/documents/689_CC_moz.pdf.

4. FAO (Food and Agriculture Organization of United Nations). (2012) The State of Food Insecurity in the World. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome

5. SETSAN (Secretariado Técnico de Segurança Alimentar e Nutricional). (2014) Relatório de estudo de base de segurança alimentar e nutricional em 2013. Maputo: Ministério da Agricultura e Segurança Alimentar. Maputo

6. Thiefelder. C., R. Matemba-Mutasa. W. Bunderson. M. Mutenje. I. Nyagumbo and W. Mupangwa. (2016) "Evaluating manual conservation agriculture systems in Southern Africa. Agriculture. " Ecosystems and Environment Journal. 222: 112-124

7. Adam, R., and M. Quinhentos, M. (2018) *Interests and perceptions of agriculture among rural youth in Mozambique: A summary brief.* Mexico City: CIMMYT

This report was prepared as one of the outputs of the SIMLESA program. SIMLESA was financed by the Australian Centre for International Agricultural Research (ACIAR) and implemented by the International Maize and Wheat Improvement Center (CIMMYT) in collaboration with numerous partners, including national agricultural research institutes, other CGIAR centers (ILRI and CIAT), and the Queensland Alliance for Agriculture and Food Innovation (QAAFI) of the University of Queensland, Australia and ASARECA. We would like to especially acknowledge the many years of technical and administrative support of CIMMYT scientists during the implementation of the SIMLESA program, including the preparation of this report. The contribution of all our collaborators (those mentioned here and many more not mentioned), including farmers who hosted trials, local businesses, government departments and researchers are gratefully acknowledged.

IIAM Instituto de Investigação Agrária de Moçambique

ETHIOPIAN INSTITUTE OF AGRICULTURAL RESEARCH

KALRO Kenya Agricultural & Livestock Research Organization

Ministry of Agriculture, Irrigation & Water Development

NARO NATIONAL AGRICULTURAL RESEARCH ORGANISATION

RAB RWANDA

TARI Transforming Agriculture

ARC • LNR Excellence in Research and Development

ASARECA Transforming Agriculture for Improved Livelihoods

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

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

THE UNIVERSITY OF QUEENSLAND AUSTRALIA