POLICY BRIEF:

Opportunities for climate change adaptation and resilience through promotion of Conservation Agriculture in Mozambique

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Introduction

The Republic of Mozambique is considered to be one of the countries which is most vulnerable to climate change, particular as a result of the predicted impacts of climate change on productive sectors such as agriculture (which is the primary livelihood basis for ~80% of the population and which contributes ~31.5% of Mozambique's Gross Domestic Product (Mazvimavi, 2011)). The country's impoverished rural population (the majority of whom are reliant on subsistence agriculture) are vulnerable to climaterelated hazards such as drought and rainfall variability, floods, soil erosion and saltwater intrusion, all of which impact negatively on agricultural production and which can potentially result in total crop failure. In consequence, it is clear that Mozambique's objectives for sustainable socio-economic development will depend on the development of effective strategies and practices to safeguard the productivity of the agriculture sector from the effects of climate change. The identification of such strategies and practices can be informed by the extensive experience, lessons learned and observations generated by past initiatives focused on adaptation in the agriculture sector, including promotion of Conservation Agriculture (CA) and other forms of climate-smart farming.

Policy rationale for Conservation Agriculture in Mozambique

Mozambique's National Climate Change Adaptation and Mitigation Strategy (ENAMMC), the country's most comprehensive policy instrument to address climate change, includes 'Agriculture, fisheries, food security and nutrition' as one of eight areas for strategic action. Consequently, it is clear that GoM's policies recognise the threat posed by climate change to socio-economic development, including the climatevulnerable and economically important agriculture sector. An important component of Mozambique's strategy for the agriculture sector to adapt to climate change is the promotion of Conservation Agriculture (CA), which is a set of management practices that minimize soil disturbance, incorporate legumes through rotations or intercropping, and maintain crop residues on the soil surface (Grabowski and Mouzinho, 2013). The strategic importance of CA approaches to Mozambique's climate change response is demonstrated by the inclusion of "Number of households engaged in Conservation Agriculture" as a high-level objective indicator in the country's National Climate Change Monitoring and Evaluation Framework (SNMAMC), as well as the strong emphasis on CA approaches in the Ministry of Agriculture and Food Security's (MASA) 'Action Plan for Climate Smart Agriculture'.

However, despite the considerable policylevel support for CA approaches, there remains a relatively low level of adoption of CA among smallholder subsistence farmers at the field level. The challenges to promotion and uptake of CA can be attributed to a diverse set of preexisting barriers (including institutional, financial, human capacity and other barriers). Furthermore, despite having already been the focus of considerable study and research, there are still divergent views between practitioners on the relevance and efficacy of the CA method in the context of Mozambique. Therefore, the delivery of Mozambique's key national objectives for climate change adaptation, rural food security and socio-economic development is heavily reliant on the identification and upscaling of cost-effective, locally appropriate approaches for adaptation in the agriculture sector. The delivery of Mozambique's objectives for climate change adaptation through promotion of Conservation Agriculture, although ambitious, can be achieved if the information and successful approaches generated by past initiatives can be successfully leveraged and communicated to key decisionmakers, project practitioners and extension workers.

Benefits of CA approaches vs. conventional farming

One of the main benefits of CA approaches is the **increased resilience of crops to climate hazards and shocks** such as drought. CA approaches based on reduced tillage and soil disturbance, as well as incorporating additional crop residues and legume intercrops, promotes the accumulation of soil organic matter (SOM). The addition of SOM results in **increased water-holding capacity** and infiltration rates of soils, thereby reducing the severity of drought impacts and water stress on crops. In addition, the addition of SOM and atmospheric nitrogen fixed by legumes results in **increased soil fertility** and nutrient availability, thereby increasing crop yields while reducing the demand for costly fertiliser inputs.

In contrast, the traditional approaches practiced by the majority of Mozambican farmers are associated with **declining SOM content and soil fertility** through repeated soil disturbance (e.g. digging with hoes, use of mouldboard plough), cultivation of monocrops and removal of crop residues (e.g. for use as livestock feed). Through repeated cultivation and disturbance, conventional farming approaches lead to the **degradation of soils and diminished productivity**, as a result of: i) reduced water infiltration and water-holding capacity of soils; and ii) reduced fertility and increased soil acidity. In the long-term, the continuous degradation of soils ultimately results in the abandonment of exhausted farmland and the clearance of native vegetation to establish new plots.

Figure 1, below, provides a comparison of the structure of soils managed under CA principles compared to soils under conventional tillage.

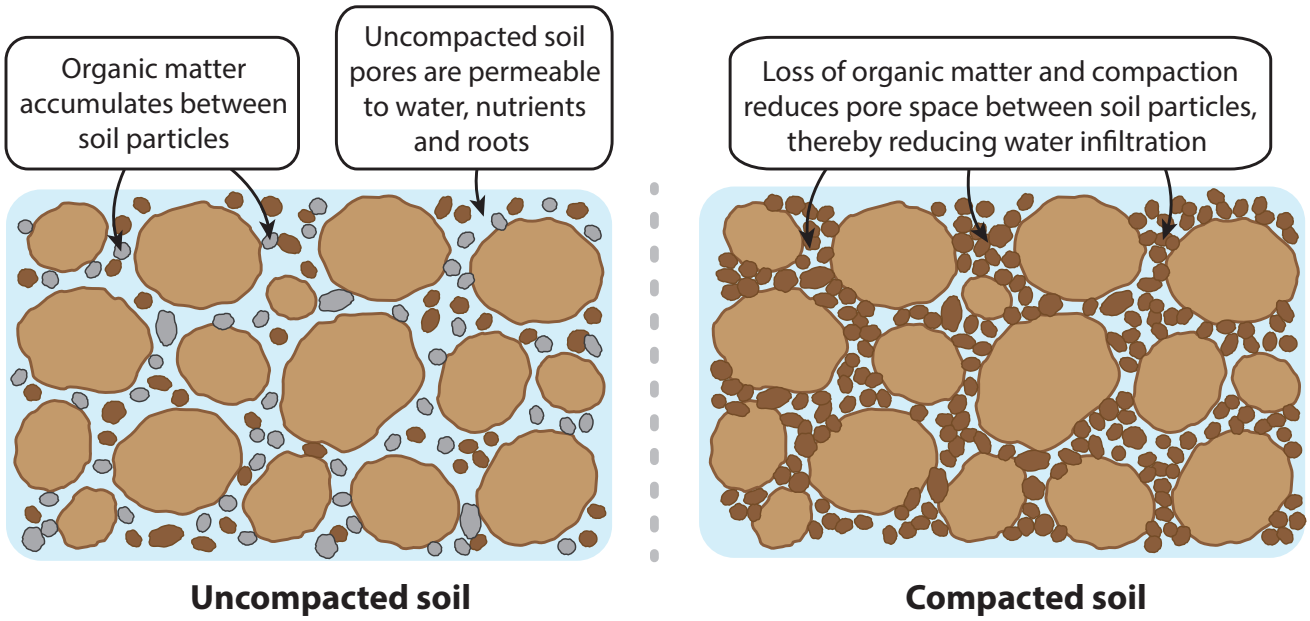

Figure 1 Comparison of uncompacted, organic matter-rich soils under CA management (left) vs. compacted, low organic matter soils under conventional tillage (right)

Summarised effects of Conservation Agriculture compared to Conventional Farming approaches

This study undertook a literature review across a wide range of previous research and past initiatives focused on CA approaches in Mozambique, with the aim of identifying and quantifying the main benefits of CA approaches compared to Conventional Farming (CF). The range of benefits of CA approaches identified by this study can be categorised into the following areas: i) **increased costeffectiveness, efficient use of land and inputs**; ii) **increased yields and crop productivity**; and iii) **improved livelihoods, food security and household wellbeing** (see Figure 2, below).

It must be emphasised that the range and scale of potential beneficial effects of CA approaches is highly variable between specific crops, agroecological regions and methods and should not be assumed to be applicable to all farming systems and regions of Mozambique. Some highlights of the data generated by previous research on CA in Mozambique are summarised diagrammatically in Figure 2 (overleaf, below) depicting examples of the cumulative beneficial effects of CA relative to CF approaches. The data provided in Figure 2 is described in more detail in Table 1, opposite page (including references and location of study site). Detailed summaries of the main research findings are provided in the full Technical Report titled "Problems and Solutions for Climate Change Resilience in Mozambique".

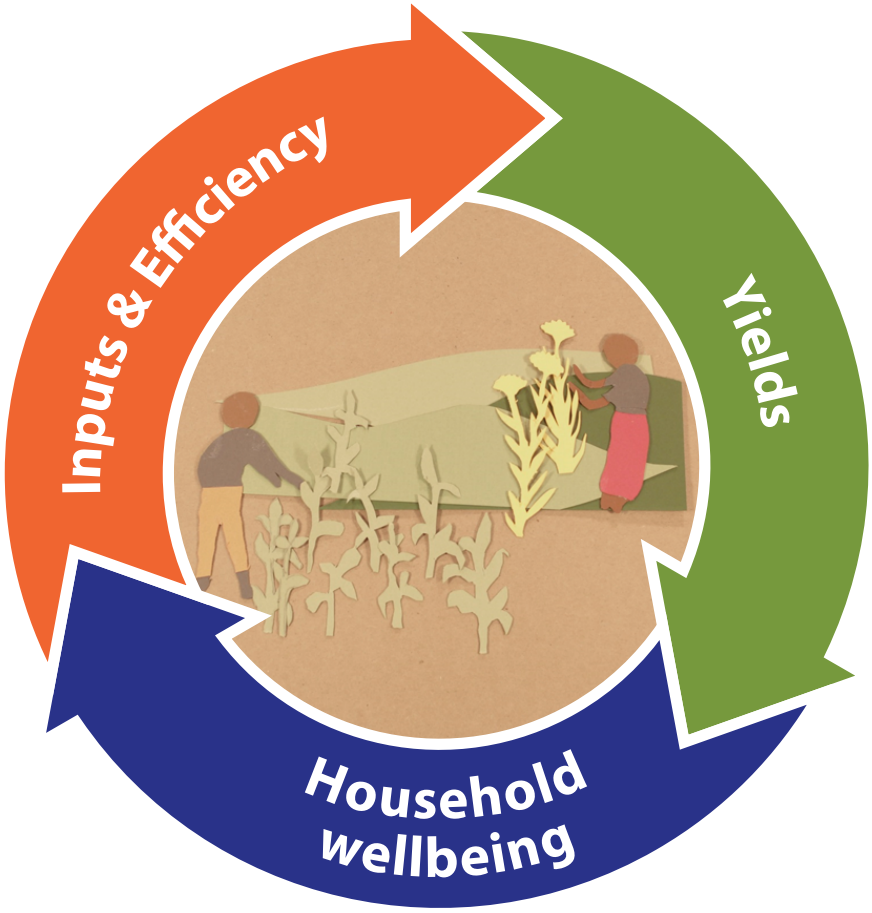

Figure 2 Summarised beneficial impacts of Conservation Agriculture (CA) approaches compared to Conventional Farming (CF) reported in Mozambique

Table 1 Effect of CA vs CF approaches: Inputs, efficiency, cost-effectiveness and land equivalent ratio

	Variable	CA vs. CF[1]	Notes/methods	Reference
Efficiency & Cost-effectiveness	**Energy inputs for crop preparation (GJ/hectare)**	CA: 14.8 CF: 16.2	Central Region; low-input techniques	Nkala et al. (2012a)
	Ratio of Energy Outputs (EO) to Inputs (EI)	CA: 2.7–5.9 CF: 1.1–2.2		
	Land Equivalent Ratio[2]	CA1: 1.2–1.6 CA2: 1.05–1.4 CF: 1	Manica, Gorongosa (Central Region); CA1: Within-row intercrop; CA2: Alternate-row intercrop	Rusinamhodzi et al. (2011)
	Time spent weeding (hours)	CA1: 22.3 CA2: 26.4 CF: 17.6		
	% change irrigation demand	CA 60% < CF	Sofala; high-input techniques (cover crops, mulching and crop rotation)	Taimo et al. (2006)
	% change weeding labour	CA 90% < CF		
	% change land preparation labour	CA 75% < CF		
Yields & Productivity	**% Increase maize yield**	CA 30% > CF	Sofala; high-input techniques (cover crops, mulching and crop rotation)	Taimo et al. (2006)
	Maize yield, 2009–2011 seasons (tonnes/hectare)	CA: 1.2–3.2 CF: 0.8	Cabo Delgado; low-input techniques (planting basins, mulch, intercropping)	Dambiro et al. (2011)
	Maize yield, 2006–2010 seasons (tonnes/hectare)	CA: 2.1–4.7 CF: 0.9–1.8	Central Region; low-input techniques	Nkala et al. (2012)
	% of farmers that report increased productivity	CA: 72 CF: 19		Nkala et al. (2011)
Livelihood, food security & wellbeing	**Crop failure**	CA1, CA2 survived 2009/2010 dry spell CF crops failed	Manica, Gorongosa (Central Region); CA1: Within-row intercrop; CA2: Alternate-row intercrop	Rusinamhodzi et al. (2011)
	% Farmers reporting satisfaction	CA: 73–84; CF: 57–61		
	Livelihoods and wellbeing	CA farmers have higher animal ownership, productive asset ownership, quality of housing materials, and access to water and sanitation	Tete and Manica (Central)	McNair et al., 2012
	Marketing of surplus maize	CA farmers purchase less maize, and sell more, relative to CF farmers		

1 Conservation Agriculture (CA) compared to Conventional Farming (CF)

2 Land Equivalent Ratio (LER) is the proportion of area under sole cropping ('conventional monocrop') compared to the area under intercropping needed, to give equal amounts of yield. LER is a measure of the productivity of growing two or more crops together compared to monoculture

Factors which promote the likelihood of adoption of CA approaches

Through a review of all available scientific literature, project reports and field guides, this study found that there are several common factors which support successful, sustained adoption of adaptation practices such as CA in Mozambique. For example, many of the underlying socio-economic barriers that undermine efforts to promote CA, increase the productivity of agriculture, and adapt to climate change are common to the majority of the country's rural communities, despite Mozambique's socio-economic and agro-ecological variability. Therefore, while it is apparent that the feasibility and performance of various CA practices is highly context and sitespecific, many of the factors which support the sustained adoption of new agricultural or adaptation practices are widely applicable across Mozambique. Through the identification of these common factors, effective climate adaptation responses that work and increase resilience for the most vulnerable can be identified. Figure 3, below, provides a graphical depiction of the major factors identified which influence or support the sustained adoption of agricultural and adaptation practices such as CA in Mozambique. Table 2, overleaf, summarises the rationale behind each of the factors identified and provides recommendations of good practices and actions to be prioritised by future initiatives aiming to promote CA and other adaptation actions in the agriculture sector

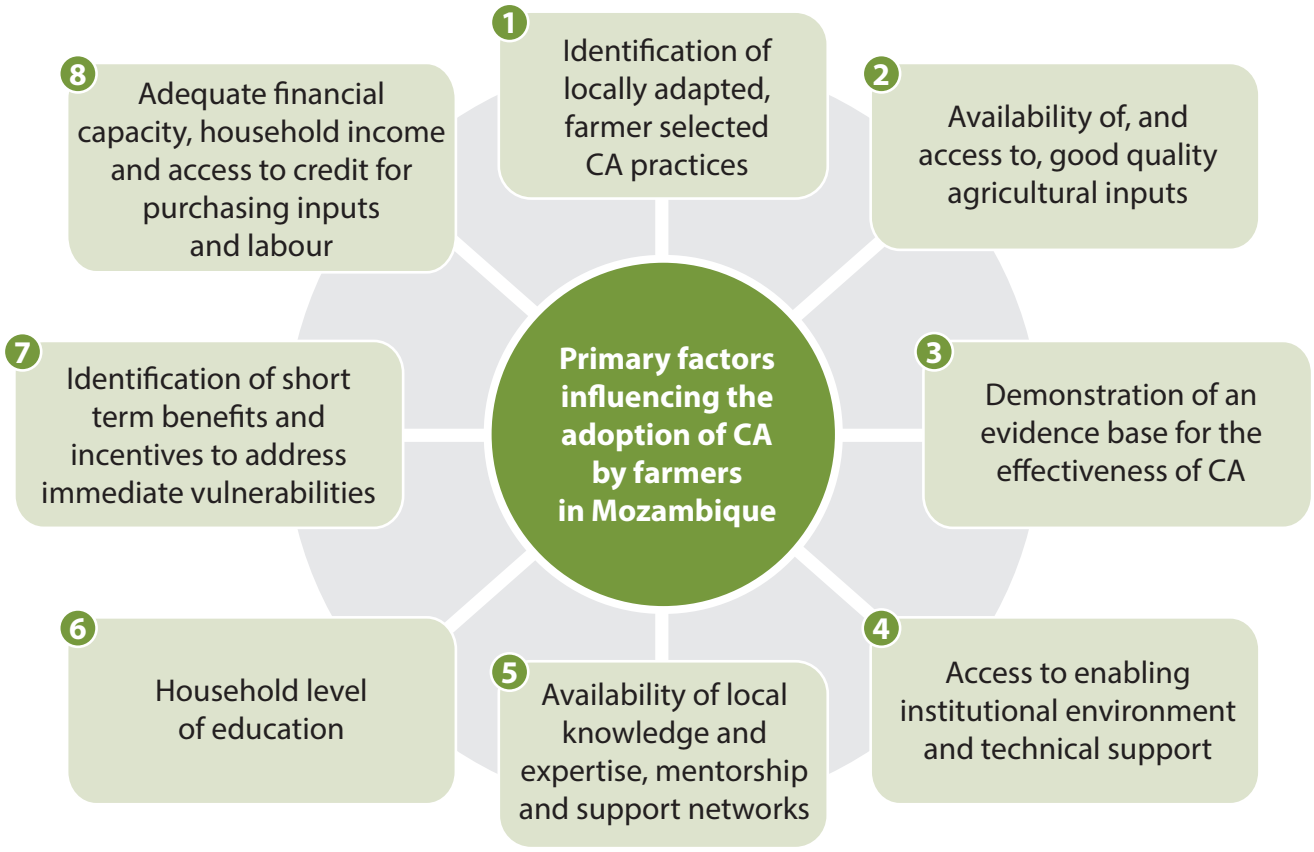

Figure 3 Primary factors which influence or support the sustained adoption of agricultural and adaptation practices such as CA in Mozambique

Table 2 Primary factors and recommended practices which promote the adoption of adaptation practices such as CA in Mozambique

Factors to promote sustained adoption	Rationale
1. Identification of locally-adapted, farmer-selected CA practices	CA has the potential to benefit smallholders throughout Mozambique, but only if practices are adapted to local conditions. There are no 'one-size-fits-all' solutions across all crops and regions. Most of those farmers who practice CA have generally redesigned or altered 'prescribed' CA approaches to fit their local context and circumstance. Approaches and practices identified in participation with farmers are more likely to be sustained.
2. Availability of, and access to, good quality agricultural inputs	Sustained adoption of CA practices is partly dependent on easy local availability of inputs such as improved seeds, manure/compost, agro-chemicals, implements and application equipment. The use of improved inputs is most feasible and sustainable for those farmers who have: i) the means to purchase inputs; ii) access to information and guidance of other farmers and experts; and iii) technical capacity and education to interpret and adapt successful approaches to their context. In the case of farmers who cannot afford or access inputs, low-input CA approaches based on locally-available materials are more likely to be sustained than high-input methods based on purchased materials.
3. Demonstration of an evidence base for the effectiveness of CA	Farmers are more likely to support practices which result in observable benefits (e.g. reduced labour costs or increased productivity). Therefore, efforts to promote CA based on the generation of long-term benefits will be supported by investments to demonstrate and strengthen the evidence base for the effectiveness of CA, including public demonstrations. In addition, the selection of locally appropriate CA approaches should try to identify activities which will generate short-term, perceptible benefits that will encourage sceptical farmers to persist with CA practices until additional long-term benefits such as increased soil fertility and improved water holding capacity are realised.
4. Access to enabling institutional environment and technical support	Access to technical support such as extension services, supporting NGOs, agricultural co-operatives or farmers clubs is correlated with higher use of inputs, larger harvest surplus and greater household assets. Limited or inconsistent availability of extension services is a major barrier to Mozambique's efforts to upscale CA. Farmers who cannot access technical support are less likely to risk the adoption of new and untested practices and are unlikely to voluntarily adopt practices such as CA without a supporting enabling environment. In addition, the education level of the household head is positively correlated with the likelihood of adopting new technologies or practices, and therefore the measures used to promote and demonstrate CA may be ineffective to engage the least educated households. The identification of local 'champions' and lead farmers, the establishment of farmer's clubs, and the engagement of supporting NGOs will assist those households with the least capacity to adopt new approaches.
5. Availability of local knowledge and expertise, mentorship and support networks	
6. Household level of education	
7. Identification of short-term benefits and incentives to address immediate vulnerabilities	Poor farmers tend to be averse to risks, and will prioritise immediate household needs such as food purchases, transport and health care over costs such as purchase of agricultural inputs. The high costs of inputs e.g. herbicide, application equipment, and labour, may cause farmers to revert to conventional methods before the long-term benefits of CA are realised. A lack of cash income, limited access to credit and low capacity for financial management are barriers to the adoption of CA practices, and to agricultural and rural development in general. Factors which will increase the likelihood of sustained adoption of CA by poor households include: i) identification of opportunities to generate additional household income e.g. cash crops, cooperative marketing; ii) identify locally appropriate low-input CA approaches for input-constrained households; and iii) sustained development of initiatives for rural finance, micro-credit and entrepreneurial development.
8. Adequate financial capacity, household income and access to credit for purchasing inputs and labour	

Recommendations to support delivery/achievement/success of policy priorities and objectives for adaptation in Mozambique's agriculture sector

In general, Mozambique's institutional arrangements and policies on climate change are clear and wellaligned: from the nationallevel priorities established in the SNMAMC, down to the Local Adaptation Plan (PLA) process which provides an opportunity to integrate principles such as CA and other forms of climatesmart agriculture into local-level land planning. As a result of ongoing investments in technical capacity, strengthened institutions and lessons learned generated by past initiatives, there exists a solid foundation for the implementation of Mozambique's strategic objectives on climate change in general and adaptation through CA in particular. This study developed multiple recommendations to support the delivery of national priorities for adaptation through promotion of CA approaches which are described in detail in the full Technical Report, some key recommendations of which are summarised below.

One of the clearest messages that emerged from review of all past research was that the development of participatory, locallyadapted, farmerselected CA practices supports the greatest likelihood of sustained adoption. This is recommended as an alternative to the conventional 'technology transfer' approach which promotes CA as a package of practices and principles. Another factor commonly cited in the literature, and supported by data from the TIA survey, is that availability of local knowledge and expertise, mentorship and support networks are enabling factors that support sustained adoption of CA and other alternative approaches to agriculture. Additional key findings related to understanding the factors and incentives that influence farmer decisionmaking, where it was found that most farmers are unable to wait for the longterm benefits of CA to be realised as a result of the immediate socioeconomic challenges and poverty that tends to influence decisionmaking in most impoverished rural households. The most vulnerable and impoverished households require sustained technical and financial assistance in order to transition to sustainable and self-reliant CA approaches (especially those approaches based on the purchase of inputs and labour) while self-sufficiency should be encouraged for those farmers with middle-to-high incomes. Therefore, some key recommendations generated by this study recommends include:

Recommendations

- Adopt participatory approaches that include farmers, extension agents and researchers in a collaborative effort to identify locally appropriate practices.
- Prioritise establishment of farmer's cooperatives and clubs to encourage a 'horizontal' transfer of knowledge and experience within existing farmers' networks.
- Initiatives which aim to promote longterm CA benefits must also identify practices that generate tangible nearterm benefits, to incentivize continuation of CA approaches
- Sustained budgetary and political support is needed to ensure the implementation of the priority actions identified in the Action Plan for Climate Smart Agriculture, including expansion of the national extension network and increased coverage of Farmer Field School facilities.
- Develop value chains and markets for agricultural inputs e.g. agrochemicals, hybrid seed, and credit and financial/ banking services.
- Sustained support and technical assistance from international partners should be directed to expansion of these successful approaches.

Further reading

Past initiatives implemented by government-, NGO- and international development organisations have generated multiple field manuals, training guides and planning documents to support the practical implementation of CA and other climatesmart agriculture approaches. The target audience of these products primarily comprises farmers, farmer's unions and clubs, extension workers and other stakeholders participating in the active design or implementation of CA approaches. Several examples of knowledge products identified by this study – which include a wide range of approaches, from simple low-input methods to relatively complex and high-input methods that are suitable for a diversity of stakeholders with differing degrees of technical capacity – are summarised in Table 3, below.

Table 3 Training manuals and field guides developed for CA approaches in Mozambique

Title	Brief description
Manual de AC para técnicos e agricultores (Calegari and Taimo, 2007, PROMEC initiative). *Available in Portuguese*	Technical manual for planning and implementing CA approaches targeted at extension workers, project implementers, and individuals with an intermediate-to-advanced level of technical capacity. Primarily targeted at Manica, Sofala and Inhambane provinces. Includes: i) definitions and benefits of CA; ii) descriptions of appropriate crop-specific practices and planting combinations; iii) potential cover crops and planting combinations; iv) control of pests and diseases; and v) options for upscaling.
Guião de facilitador abordagem de Escola na Machamba (EM) Agricultura de Conservação (AC) Regenerativa (Kamp, 2011, CARE Initiative). (Farmer Field School Curriculum for Conservation Agriculture). *Available in Portuguese and English*	Facilitating guide and curriculum for 'Escola na Machamba (EM)' (farming field schools) teaching regenerative CA techniques to smallholder farmers. The establishment of a high-quality curriculum for a season-long training programme to promote transfer of CA approaches and technologies to farmers, which can be adapted to different crops & agro-ecological zones. This facilitator's manual was developed for use at CARE's Farmer Field Schools in Nampula province but the general approach can be adapted to other provinces and contexts.
Guião Para Facilitadores. Manual de Facilitação de Práticas Agrárias e de Habilidades para a Vida. (FAO, undated) (Junior Farmer Field and Life Schools Inventory). *Available in Portuguese and English*	A guide for facilitators and trainers at FAO's Junior Farmer Field and Life Schools. Trained extension workers, teachers and social animators use this participatory methodology to pass on agricultural knowledge and life skills to both boys and girls. For one entire school year, a multidisciplinary team of facilitators leads participatory sessions with a group of about 30 youth who range in age from 12 to 18. The manual was developed for Manica and Sofala but can be applicable to other regions.
Manual de Agricultura Sustentável (Nhancale and Chilaule, 2010, UNAC initiative). *Available in Portuguese*	A field guide for sustainable agriculture, including definitions of terms and concepts. Includes examples of specific Sustainable Agriculture practices, including land management. The field guide includes a strong emphasis on graphic illustrations and figures to support ease of interpretation by a diverse range of stakeholders and is appropriate for users with a basic/ minimal level of technical expertise.

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