PROBLEMS AND SOLUTIONS FOR CLIMATE CHANGE RESILIENCE AND ADAPTATION IN MOZAMBIQUE

State of Adaptation Knowledge, Policies and Practices to support Conservation Agriculture

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PART IV KEY FINDINGS AND RECOMMENDATIONS

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Acronyms

Acronym	Portuguse title	English title
ACCRA	Aliança Africana de Resiliência às Mudanças Climáticas	African Climate Change Resilience Alliance
ACM	Academia de Ciências de Moçambique	Mozambique Academy of Sciences
AENA	Associação Nacional de Extensão Rural	Association of Extensionists
AFAAS	Fórum Africano para Serviços de Assessoria Agrícola	African Forum for Agricultural Advisory Services
AfDB	Banco Africano de Desenvolvimento	African Development Bank
AGRA	Aliança para a Revolução Verde em África	Alliance for Green Revolution in Africa
ALP	Programa de Aprendizagem de Adaptação	Adaptation Learning Programme
APL-II	Programa de Manutenção e Gestão de Estradas e Pontes	Roads and Bridges Maintenance and Management Programe
BLICRP	Projecto de irrigação e resiliência climática do Baixo Limpopo	Baixo Limpopo Irrigation and Climate Resilience Project
CA	Agricultura de conservação	Conservation Agriculture
CAADP	Programa abrangente de desenvolvimento da agricultura em África	Comprehensive Africa Agriculture Development Programme
CAWG	Grupo de Trabalho de Agricultura de Conservação	Conservation Agriculture Working Group
CBO	Organização baseada na comunidade	Community-based Organisation
CC	Mudancas Climáticas	Climate change
CCD	Conselho Consultivo Distrital	District Consultative Council
CCCPP	Projecto de Cidades e Mudanças Climáticas	Cities and Climate Change Project
CCP	Projecto de Mudanças Climáticas	Climate Change Project
CERUM	Centros de Recursos de Uso Múltiplo	Multiple Use Resource Centre
CF	Agricultura convencional	conventional farming
CGCMC	Centro de Gestão de Conhecimento sobre Mudancas Climaticas	Climate Change Knowledge Management Centre
CNAs	Avaliações de Necessidades de Capacitação	Capacity Needs Assessments
CoM	Council of Ministers	Council of Ministers
CONDES	Conselho Nacional de Desenvolimento Sustentável	National Sustainable Development Council
COP	Conferência das partes	Conference of the parties
CSA	Agricultura com inteligência climática	Climate-Smart Agriculture
DARIDAS	Direcção de Desenvolvimento das Zonas Áridas e Semi-Áridas	Directorate for Development of Arid and Semi-Arid Areas
DARN	Direcção de Agronomia e Recursos Naturais	Directorate of Agriculture and Natural Resources
DFDTT	Direcção de Formação, Documentação e Transferência de Tecnologias	Directorate of Training, Documentation, and Technology Transfer

Acronym	Portuguse title	English title
DINAB	Dirrecção Nacional do Ambiente	National Directorate for Environment
DM	Gestão de desastres	Disaster Management
DNE	Direcção Nacional de Environment	National Directorate for Environment
DNEA	Direcção Nacional de Extensão Agrária	National Directorate for Agrarian Extension
DPAF	Direcção de Planificação, Administração e Finanças	Directorate of Planning, Administration and Finance
DPCI	Direcção de Planificação e Cooperação Internacional	Directorate for Planning and International Affairs
DPO	Operação de políticas de desenvolvimento das mudanças climáticas	Climate Change Development Policy Operation
DRM	Gestão do Risco de Desastres	Disaster Risk Management
DRR	Redução do Risco de Desastres	Disaster Risk Reduction
DUAT	Direito de uso e aproveitamento da terra	Right to Use and Exploit Land
E&S Africa	África Oriental e Austral	East and Southern Africa
EDR	Estratégia de Desenvolvimento Rural	Rural Development Strategy
EI	Consumo energético	Energy Inputs
ENAMMC	Estratégia Nacional de Adaptação e Mitigação de Mudanças Climáticas	National Climate Change Adaptation and Mitigation Strategy
ENDE	Estratégia Nacional de Desenvolvimento	National Development Strategy
EO	Rendimento energético	Energy Outputs
FAO	Organização de Agricultura e Alimentação	Food and Agriculture Organisation
FARA	Fórum de Pesquisa Agrícola em África	Forum for Agricultural Research in Africa
FDA	Fundo de Desenvolvimento Agrário	Agrarian Development Fund
FFS	Escolas na Machamba do Camponês	Farmer Field Schools
FNDS	Fundo Nacional de Desenvolvimento Sustentavel	National Sustainable Development Fund
FPAP	Plano de Acção de Produção de Alimentos	Food Production Action Plan
FSR	Pesquisa de Sistemas Agrícolas	Farming Systems Research
FUNAB	Fundo Nacional do Ambiente	National Environmental Fund
GCF	Fundo Verde para o Clima	Green Climate Fund
GDP	Produto Interno Bruto	Gross Domestic Product
GE	Economia Verde	Green Economy
GEAP	Plano de Acção da Economia Verde	Green Economy Action Plan
GHG	Gases do efeito de estufa	Greenhouse Gas
GIIMC	Grupo Inter-Institucional para Mudanças Climáticas	Inter-Institutional Group for Climate Change
GJ	Giga Joules	Giga Joules
GoM	Governo de Moçambique	Government of Mozambique
GRS	Estratégia da Revolução Verde	Green Revolution Strategy

Acronym	Portuguse title	English title
HYDROMET	Projecto de Transformação de Serviços Hidro-Meteorológicos para Moçambique	Transforming Hydro-Meteorological Services Project for Mozambique
IAI	Inquerito Agricola Integrado	Integrated Agricultural Survey
IFC	Sociedade Financeira Internacional	International Finance Corporation
IIAM	Instituto de Investigação Agrária de Moçambique	Research Directorate
INAM	Instituto Nacional de Meteorologia	National Institute of Meteorology
INDC	Contribuicoes destinadas e determinadas a nível nacional	Intended Nationally Determined Contribution
INE	Instituto Nacional de Estatistica	National Institute of Statistics of Mozambique
INGC	Instituto Nacional de Gestão de Calamides	National Institute for Disaster Management
INIR	Instituto Nacional de Irrigação	National Institute for Irrigation
LER	Rácios «valores» equivalentes dos terrenos	Land Equivalent Ratios
M&E	Monitoria e Avaliação	Monitoring and Evaluation
MAE	Ministério da Administração Estatal	Ministry of State Administration
MASA	Ministério da Agricultura e Segurança Alimentar	Ministry of Agriculture and Food Security
MEF	Ministério da Economia e Finanças	Ministry of Economy and Finance
MF	Ministério de Finanças	Ministry of Finance
MICOA	Ministério para a Coordenação da Acção Ambiental	Ministry of Coordination of Environmental Affairs
MINAG	Ministério da Agricultura	Ministry of Agriculture
MITADER	Ministério da Terra, Ambiente e Desenvolvimento Rural	Ministry of Land, Environment and Rural Development
MPD	Ministério de Planificação e Desenvolvimento	Ministry of Planning and Development
MSU	Universidade de Estado do Michigan	Michigan State University
MSUFSG	Grupo de segurança alimentar da Universidade de Estado do Michigan	Michigan State University Food Security Group
MTC	Ministério dos Transportes e Comunicações	Ministry of Transport & Communication
MTCESTP	Ministério da Ciência e Tecnologia, Ensino Superior e Técnico Profissional	Ministry of Science & Technology, Higher and Vocational Education
NAP	Plano Nacional de Adaptação	National Adaptation Plan
NAPA	Programa Nacional de Acção de Adaptação	National Adaptation Programme of Action
NAP-GSP	Plano Nacional de Adaptação - Programa de suporte global	National Adaptation Plan – Global Support Program
NGO	Organização não governamental	Non-Governmental Organisation
PAEI	Política Agrária e Estratégia de Implementação	Agricultural Policy and Implementation Strategy
PAAO	Plano de Acção Anual na Agricultura	Annual Action Plan in Agriculture
PAPA	Plano de Acção da Produção Agrícola	Plan of Action for Food Production
PARP	Plano de Acção para Redução da Pobreza	Poverty Reduction Strategy

Acronym	Portuguse title	English title
PARPA	Plano de Acção para a Redução da Pobreza Absoluta	Action Plan for the Reduction of Absolute Poverty
PEDD	Plano de desenvolvimento distrital	District Development Plan
PEDSA	Plano Estratégico para o Desenvolvimento do Sector Agrário	Strategic Plan for the Agricultural Development
PES	Plano Economico e Social	Economic and Social Plan
PESOD	Plano Económico, Social e Orçamento Distrital	District Socio-economic and Development Plan
PESP	Plano Economico e Social Provincial	Provincial Economic and Social Plan
PIAIT	Plataforma para Investigação Agrária e Inovação Tecnológica	Mozambique Platform for Agricultural Research and Technological Innovation
PLA	Plano Local de Adaptação	Local Adaptation Plans
PNISA	Plano Nacional de Investimento do Sector Agrário	National Investment Plan for the Agricultural Sector
PPCR	Programa Piloto sobre Resiliência Climática	Pilot Programme on Climate Resilience
PROMEC	Promoção Económica de Camponeses	Economic Promotion of Peasants
PRONEA	Programa Nacional de Extensão Agrária	National Agricultural Extension Program
PQG	Plano Quinquenal do Governo	Five Year Government Plan
SADC	Comunidade de Desenvolvimento da África Austral	Southern African Development Community
SETSAN	Secretariado Técnico de Segurança Alimentar e Nutricional	Technical Secretariat for Food Security and Nutrition
SIMA	Sistema de Informação de Mercados Agrícolas de Moçambique	Agricultural Market Information System of Mozambique
SISNE	Sistema Nacional de Extensão	National Extension System
SLWRMP	Gestão sustentável de recursos hídricos e terrestres	Sustainable Land and Water Resources Management
SNMAMC	Sistema Nacional de Monitoria e Avaliação das Mudanças Climáticas	National Climate Change Monitoring and Evaluation Framework
SOM	Matéria orgânica do solo	Soil Organic Matter
SPCR	Programa Especial de Resiliência Climática	Special Program on Climate Resilience
TIA	Trabalho de Inquerito Agricola	Agricultural Enquiry Work
UEM	Universidade Eduardo Mondlane	Eduardo Mondlane University
UMC	Unidade Para as Mudanças Climáticas	Climate Change Coordination Unit
UN	Nações Unidas	United Nations
UNAC	União Nacional dos Camponeses	National Peasant's Union
UNDP	Programa das Nações Unidas para o Desenvolvimento	United Nations Development Program
UNFCCC	Convenção-Quadro das Nações Unidas sobre Mudanças Climáticas	United Nations Framework Convention on Climate Change
WB	Banco Mundial	World Bank

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Introduction

The Republic of Mozambique is considered to be particularly vulnerable to the predicted impacts of climate change, as a result of the severity of predicted climate change in the country as well as the limited ability of the country's vulnerable sectors to respond to climate change. The agriculture sector, which is the primary livelihood basis for (80%) of the population and which contributes ~31.5% of Mozambique's Gross Domestic Product (Mazvimavi, 2011), is considered to be particularly vulnerable to the impacts of climate change. As described in Mozambique's Intended Nationally Determined Contribution (INDC, RoM, 2016), the country's impoverished rural population (the majority of whom are reliant on subsistence agriculture) are vulnerable to the effects of climate-related hazards such as drought and floods, soil erosion and saltwater intrusion, all of which impact negatively on the productivity of the agriculture sector (RoM, 2016). In consequence, it is apparent that Mozambique's socio-economic development will be dependent on the development of strategies to increase the productivity and climate-resilience of the agriculture sector.

In response to the observed and predicted impacts of climate change, one of the strategic actions that will be prioritised by the Government of Mozambique (GoM) is to "*Increase the resilience of agriculture, livestock and fisheries, guaranteeing the adequate levels of food security and nutrition*" as part of the National Adaptation Plan currently in development (RoM, 2016). Further, the country's National Climate Change Adaptation and Mitigation Strategy (ENAMMC) includes 'Agriculture, fisheries, food security and nutrition' as one of eight areas for strategic action, noting that "*conservation of agricultural land, as well as the promotion of resilient crops, is crucial*" for the country to adapt to climate change. Consequently, it is clear that GoM's policies recognise the threat posed by climate change to Mozambique's socio-economic development, including the climate-vulnerable and economically important agriculture sector. Furthermore, the strategic priorities elaborated in Mozambique's recent policy documents indicate a strong emphasis on the sectors of land use change, forestry and agriculture as a component of the country's response to climate change. Within the agriculture sector, it is anticipated that the 'Conservation Agriculture' (CA) approach will be an important aspect of GoM's priority actions, which will be supported by the inclusion of "Number of households engaged in Conservation Agriculture" as a high-level objective indicator of the national climate change strategy.

The precedent for CA is well-established in Mozambique, where the technique has been demonstrated and promoted for over two decades. However, despite Mozambique's well-established expertise and experience in the CA approach, there remains a relatively low level of adoption of the approach among the smallholder subsistence farmers that dominate the country's agriculture sector. 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. Despite the existence of structures for coordination and collaboration between stakeholders working in the broad theme of climate change, there are no active structures for sharing of information, best practices, results, methodologies etc., on the topic of CA in particular or Climate-Smart Agriculture (CSA) in general. These gaps in information and coordination may potentially undermine the efficiency and cost-effectiveness of Mozambique's climate change adaptation strategies by increasing the risk of duplication of efforts or promotion of ineffective/maladaptive actions.

This technical report aims to assess the state of available knowledge and information to guide Mozambique's response to climate change, particularly within the agriculture sector, from the centralised level of national policies and strategies down to the level of implementation 'in the field'. Part I of the study provides a description and assessment of the complex legal and institutional framework which governs the country's strategies for socio-economic development, agricultural development and climate change adaptation, and the challenge of aligning and coordinating the mandates of the various institutional stakeholders (including Chapter 1 on the legal and policy framework, and Chapter 2 on the Institutional Arrangements and Coordination). Part II of this study provides a summary and analysis of recent initiatives which promoted the CA approach, including an assessment of the bio-physical and socio-economic impacts of CA as well as a summary of the primary factors which influence a farmer's decision to adopt adaptation practices such as CA. This includes the information in Chapter 3 on past projects and initiatives focused on Conservation Agriculture (CA) in Mozambique, and Chapter 4 which summarises the factors and best practices which influence the likelihood of sustained adoption of CA by farmers and identifies priorities for research and information needs to promote the upscaling of CA. Part III of the study describes the state of knowledge and information products in the form published, publicly-accessible products and services that are available to support the promotion and adoption of CA approaches. Finally, Part IV of the study provides a set of recommendations for policy-makers, researchers, and field workers/CA practitioners, respectively.

PART I

Institutional and Policy Review

1 Legal framework on climate change in Mozambique

Mozambique has moved progressively in developing an institutional framework and programmatic activities to address climate change, and as a result the country has steadily built a platform of institutional knowledge and experience on climate change adaptation complemented by a supporting policy environment. At the institutional level, the country's legal framework has been revised to align with the country's ambitions and international commitments to reduce vulnerability to climate change (CC) and support low-carbon development initiatives. While the development of Mozambique's institutional framework is an ongoing and iterative process that considers and responds to emerging priority actions and information related to CC, Mozambique's governance and institutional framework is also heavily influenced by the pressing socio-economic challenges of an impoverished post-conflict state and has undergone significant restructuring at the Ministerial level in the last 20 years. One consequence of the frequent restructuring and revisions of the institutional framework is that there is a need to provide updated summaries of the country's institutional framework to inform emerging research and funding proposals for climate change-focused initiatives.

The World Bank-led Pilot Programme on Climate Resilience (PPCR) initiative in Mozambique developed a comprehensive summary of the major milestones in the development of the national policy framework on climate change in the period ~1994 – 2015 (CONDES, 2015). Notable examples of policies and strategies which include consideration of CC during this period include *inter alia*:

- Poverty Reduction Strategy (PARP);
- Strategic Plan for the Agricultural Development (PEDSA);
- Strategy for Basic Social Action;
- Tourism Strategy;
- National Water Resources Strategy;
- Master Plan for Disaster Management;
- Disaster Management Law;
- Strategy for the Intervention in Informal Settlements in Mozambique and respective Action Plan;
- Strategy for Gender, Environment and Climate Change;
- Energy Strategy;
- National Development Strategy (ENDE);
- National Climate Change Adaptation and Mitigation Strategy (ENAMMC);
- National Climate Change Monitoring and and Evaluation Framework (SNMAMC)

The priority actions and investments identified by these policy instruments (discussed further below) reflect the Government of Mozambique's (GoM) recognition of CC and extreme weather events as one of the most significant threats to the development of the country across multiple sectors and socio-economic contexts. This study will mainly consider the institutional and policy framework for adaptation in the agriculture sector and inter-related sectors of rural development and land use, and therefore will not provide detailed analysis of Mozambique's framework for other climate-sensitive sectors such as tourism, fisheries, energy, water resources or urban development.

Mozambique's active participation in the United Nations Framework Convention on Climate Change (UNFCCC) has played an important role in facilitating the delivery of financial and technical assistance for Mozambique's response to CC. The country's international obligations related to CC, detailed below, have resulted in the identification of explicit priorities for CC mitigation and adaptation

that are increasingly integrated into national development plans and sectoral strategies.

1.1 International Conventions on Climate Change

Mozambique is a signatory to the Rio Convention and an active participant in international commitments to address climate change through the UNFCCC, and submitted the country's first National Communication to the UNFCCC in 2006. The most recent submissions to the UNFCCC which guide ongoing development efforts and international support towards Mozambique's response to climate change are summarised below.

1.1.1 National Adaptation Program of Action

The National Adaptation Program of Action (NAPA) was the first policy document in Mozambique that specifically addressed the issue of climate change adaptation and mitigation. The NAPA was prepared by the now-defunct MICOA in 2007 in participation with multiple relevant agencies at the national and sub-national levels and was politically sanctioned by the Council of Ministers (CoM) in 2007 (World Bank, 2014). The NAPA outlined interventions in four major areas (CONDES, 2015), namely:

- Strengthening of the early warning system;
- Strengthening the capacities of agricultural producers to cope with climate change;
- Improve the knowledge and improving the management of surface water resources; and
- Promote actions to decrease erosion and establish sustainable fishery activities.

As a result of the inclusion of climate-vulnerable agricultural producers as a priority for future adaptation initiatives, the NAPA resulted in increased availability of technical support and international funding for numerous new initiatives to benefit Mozambique's smallholder farmers, including numerous projects with a focus on Conservation Agriculture (CA) and other forms of Climate-Smart Agriculture. In the current institutional framework, most of the activities conceived by the initial NAPA are implemented through the more recently established ENAMMC led by the current environment ministry restructured as Ministry of Land, Environment and Rural Development (MITADER) (CONDES, 2015) (*both MITADER and the ENAMMC are described further below*).

1.1.2 Intended Nationally Determined Contribution

The Intended Nationally Determined Contribution (INDC) identifies the actions a national government intends to take under the Paris Agreement to curtail global Greenhouse Gas (GHG) emissions and attempt to limit the global increase in temperature to 2 degree Celsius. The INDC was agreed in December 2015 at the 21st session of the Conference of the Parties (COP21) and will come into effect in 2020, providing the basis for post-2020 global emissions reduction commitments included in the climate agreement. Mozambique's INDC commitments towards GHG reduction are based on the implementation of a suite of 12 policies and programmes, including sectors such as urban transport, waste management, multiple initiatives in the energy sector, and the enactment of a national REDD+ strategy. In addition, Mozambique's INDC notes the ongoing Technology Needs Assessment process, which will include the sectors of agriculture, coastal zones, and energy and waste, respectively.

1.1.3 National Adaptation Plan

Mozambique is in the process of developing a National Adaptation Plan (NAP), which will effectively replace the NAPA as the long-term guiding framework for adaptation. The SNMAMC (described below) will be the guide for future activities related to resilience and risk reduction in the NAP, and which is expected to be updated for

the following time periods: short (2015 to 2019), medium (2020 to 2024) and long (2025 to 2030) term. The National Adaptation Plan Global Support Program (NAP-GSP) assists least developed countries to effectively deal with climatic issues, with an emphasis on disaster management, disaster risk reduction, and climate change adaptation. Its support is based on three main pillars, namely: institutional support, technical support and knowledge brokering (LEDS Global Partnership, undated.). The focus in establishing the NAP-GSP is to bring greater focus and attention to medium and long-term climate change adaptation planning and budgeting.

1.2 National framework of cross-cutting policies and strategies on climate change

The most recent developments in the national institutional framework which guides Mozambique's response to CC are described below. These include cross-sectoral strategies which outline priority activities related to climate change in sectoral and cross-cutting focal areas, as well as multiple sector-specific policies and strategies. In consideration of this study's specific focus on the agriculture, the sector-specific strategies described are limited to those directly related to adaptation in the inter-related sectors of agriculture, land use, and rural development. The stakeholders responsible for implementation of the relevant policies, are described further below in Chapter 1.3. Chapter 1.4 provides a summary diagram of the alignment between institutional frameworks on climate change and agriculture, respectively, from the level of strategic priorities down to the field-level implementation of activities. The list of policy instruments provided here is not exclusive and primarily focuses on those most recent elements of the policy framework which have influenced the direction of Mozambique's strategies for climate change adaptation in general, with a particular emphasis on the development and adaptation of the agriculture sector under climate change.

1.2.1 National Adaptation and Mitigation Climate Change Strategy

The National Adaptation and Mitigation Climate Change Strategy (ENAMMC, *acronym in portuguese*) was approved by the GoM in 2012 to aid the country's strategic response to climate change. ENAMMC is the country's most comprehensive instrument to address climate change, which establishes clear actions and priorities across multiple government sectors. The implementation of ENAMMC is led by the Ministry of Land, Environment and Rural Development (MITADER, acronym in portuguese), formerly the Ministry of Coordination of Environmental Affairs (MICOA, acronym in portuguese). MITADER has the mandate to report to the Council of Ministers (CoM) on an annual basis through the framework outlined by the SNMAMC, described below. The ENAMMC is structured around three thematic areas:

- adaptation and climate risk management – which addresses interventions around eight strategic sectors, namely: Disaster Risk Reduction, Water, Agriculture, Fisheries and Food Security, Social Protection, Health, Biodiversity, Forestry and Infrastructures;
- mitigation and low carbon development - addressing interventions around 4 strategic areas, namely: Energy; Industry; Land Use, and Waste Management; and
- crosscutting issues that include institutional and legal reform for climate change which are aligned with the NAPA, the adaptation recommendations in the National Institute for Disaster Management (INGC, acronym in portuguese) Phase II studies and the PPCR program.

The strategic priorities of ENAMMC include a strong emphasis on the sectors of land use change, forestry

and agriculture under the pillars of adaptation as well as mitigation. Conservation Agriculture is an important aspect of GoM's priority actions in these areas and is reflected in ENAMMC's core result indicators as "Core Result Indicator 1.3 "Number of households engaged in CA". The cross-cutting priorities listed in ENAMMC are aligned with emerging priority actions in sectoral strategies and policies such as MASA's sectoral priorities for the agriculture sector, particularly the Strategic Plan for Agricultural Development (PEDSA, acronym in portuguese) and the National Agricultural Extension Program (PRONEA, acronym in portuguese) (described further below).

ENAMMC identifies several priority adaptation objectives relating to generation of information and knowledge on climate change, particularly within the thematic area of "Crosscutting Issues". ENAMMC notes that "research and systematic observation" of climate change is ineffective as a result of the limited availability of data measurements taken at "appropriate frequency and scale". This represents a significant barrier to determining the real impacts of climate change. Further, ENAMMC notes that the lack of inter-sectoral engagement in the systematic collection of climate data, the lack of standardization, irregularity and low quality of climate data are all barriers to effective research and observation of climate change impacts (CONDES, 2014). ENAMMC therefore prioritized the development of climate change research in topics, including, *inter alia*:

- accelerating the creation of the Knowledge Management Center in Climate Change (CGCMC, acronym in portuguese);
- creating a climate change network of multi-sectoral research teams;
- using the results of studies for the design of public policies for improving people's well-being;
- establishing a peer review system for climate change research;
- creating systems for generating and sharing knowledge among and between the government, academia, the private sector and civil society;
- adapting and enhancing (academic and other) research institutions to deal with the environment in the context of climate change;
- promoting regional and international exchange; and
- strengthening of institutions that collect data for greenhouse gas inventories and National Communications.

Another cross-cutting strategic objective highlighted by the ENAMMC relates to "Capacity-building and Technology Transfer". In the context of capacity-building (which includes some aspect of knowledge generation and transfer), ENAMMC proposes strategies to develop and enhance climate change knowledge and the capacity to intervene, including *inter alia*:

- updating the Capacity Needs Assessments (CNAs) to adjust and implement corresponding action plans;
- developing and integrating climate change content in formal and informal education programs;
- increasing general public awareness, and disseminating information on climate change – including the ENAMMC, policies and international agreement;
- building capacity in the Environment Fund, formerly known as *National Environmental Fund* (FUNAB) and now the National Sustainable Development Fund (FNDS) (described further below in Chapter 2) to guide the design and development of projects and programs to include access to international funds, and
- building the capacity for integrated management and monitoring of ENAMMC and its projects and/or programs for adaptation and mitigation, including reporting on implemented projects and programs.

1.2.2 National Climate Change Monitoring and Evaluation Framework

The National Climate Change Monitoring and Evaluation Framework (SNMAMC, acronym in Portuguese) is a national strategic framework that enables systematic monitoring and evaluation of the country's responses to climate change, by reporting on progress towards implementation of the (ENAMMC, 2015-2019, described above). The SNMAMC describes the mandate of the MITADER, to report annually to the CoM on the progress and impacts of implementation of the ENAMMC (CONDES, 2015). The SNMAMC, which was approved by the Council of Ministers in October 2014 and is currently led by the Climate Change Department is considered to be a planning and financial tool which reports on the progress made by participating institutions on the integration of climate change into their respective sectoral activities. The key components of SNMAMC are as follows:

- Framework Indicators at national and sectoral level to track progress towards ENAMMC Objectives and Results;
- Greenhouse Gas (GHG) inventories to measure emissions and move towards low carbon development;
- Climate change expenditure assessments and consistent tracking of climate change finance;
- Assessment of vulnerability to climate change at sectoral and local levels to assess changes in vulnerability and local results of adaptation policies and interventions;
- Long term program evaluation to assess the impacts and effectiveness of climate change response over a period of 10-15 years;
- Learning mechanism to understand what approaches and technologies are successful; and
- Communication and sharing of Monitoring & Evaluation (M&E) results to inform stakeholders and influence policy development and implementation (SNMAMC, 2014).

Some of the key challenges still remaining to the implementation of the SNMAMC include *inter alia*:

- ineffective mechanisms for coordination of institutions related to/responsible for monitoring and responding to climate change (including former CONDES, MITADER, Academy of Science, MASA, former FUNAB (now FNDS), DPO and others);
- limited knowledge of government staff on monitoring and evaluating the effects of climate change;
- limited availability of quality data and reporting systems from a local scale to a national level.

1.2.3 Disaster Management Law

In 1999, Mozambique approved the National Policy on Disaster Management, which outlines the context of disaster risk reduction and risk management in Mozambique. An important aspect of the Mozambique's DM policies is the clear identification of stakeholders and their respective mandates and underlying the principles behind the policy. This includes the explicit recognition of the leading role to be played by affected communities in planning, programming and implementing activities to respond to disaster risks.

The Disaster Management Law was approved in 2014 to implement the provisions of the abovementioned policy and to enable meaningful actions to promote disaster risk reduction. The DRM law empowers the local, provincial, district governments, and stakeholders as primary actors to deliver an appropriate national disaster risk reduction response in accordance with Government objectives (CONDES, 2015). This includes the establishment of local Disaster Risk Management Committees led by trained community members in participation with the INGC, described further below in Chapter 2). The plans intend to mainstream climate and disaster resilience into sector planning and budgeting, and were enacted with the support of the Strategic Programme for Climate Resilience (SPCR) initiative sanctioned by the PPCR Sub-

Committee in 2011. The Disaster Management law established mechanisms for disaster preparedness and prevention that strengthen the country's early warning systems, particularly through the establishment of a three-tiered early warning system that coordinates disaster response actions between national government, local government and households.

1.2.4 Green Economy Action Plan

In 2012, GoM adopted the National Roadmap for the Green Economy and by means of the national roadmap GoM formulated the Green Economy Action Plan (GEAP). GEAPs main aim is for Mozambique to become an inclusive middle-income country by 2030. The projected rise to being a middle-income country is based on protection, restoration and rational use of natural capital and its ecosystem services to guarantee development that is sustainable, inclusive and efficient (AfDB, 2015).

The GEAP represents an extensive effort to integrate green growth principles into Mozambique's development planning procedures, with the long-term objective to guide the mainstreaming of policies and practices for environmental sustainability during the transition towards becoming an inclusive middle-income country. Further specific objectives of the GEAP included *inter alia*:

- create the foundation of a green economy (GE) through inclusion of a green growth agenda in national development priorities;
- identify policy actions to advance a GE agenda aligned with national objectives for poverty reduction; and
- incorporate the green economy approach into planning and budgeting as well as into national accounts (AfDB, 2015).

1.3 National framework of policies and strategies on agriculture and climate change

The sustainability and development of the agriculture sector is accorded high importance in Mozambique's plans for socioeconomic development, reflecting the importance of the sector as a source of employment and food security for the majority of the country's rural population. The agriculture sector is governed and developed by several sector-specific as well as cross-cutting policies, reflecting the perceived importance of agriculture towards the achievement of broader socio-economic development goals ambitions such as those of Vision 2030 and the Sustainable Development Goals. A structural challenge which persists in Mozambique is the divide between large scale commercial agriculture and smallholder subsistence agriculture. Certain policy measures are primarily focused on increasing the economic contribution of agriculture through development of irrigation facilities, promotion of commercial outgrower schemes and identification of high-value export crops. The primary beneficiaries of the latter policy measures have been commercial farmers and international actors in the agro-commodities value chain, with relatively little increase in productivity or food security of the smallholder subsistence farming sector. The threat of climate change to the agriculture sector is recognised at the level of cross-cutting policies and climate change-specific priorities, and has resulted in the development of a climate-smart action plan for the agriculture sector. However, there remains a need to harmonise and align this priority into all future plans and investments at the field level, to include smallholder farmers in the commercialisation and development of the agro-commodities value chain while also safeguarding the food security and climate resilience of smallholders.

1.3.1 Strategic Plan for Development of Agrarian Sector

The Strategic Plan for Development of Agrarian Sector (PEDSA, acronym in Portuguese) is the main document which guides the development of Mozambique's agriculture sector, and is implemented through five-year plans and annual agricultural sector plans. The PEDSA was initially envisioned to be a 10-year plan to increase food security and yield of agriculture producers in a competitive and sustainable way, with a strong emphasis on ensuring gender-equitable social benefits. The PEDSA includes consideration of the cross-cutting challenges and threats to the agriculture sector, including issues such as gender equality, the impact of HIV/AIDS on rural communities, and the impacts of climate change and environmental degradation. The PEDSA notes that environmental challenges such as soil erosion, reduced soil fertility and the increase of soil salinization in the coastal zones, will undermine the delivery of the GoM's objectives for the sector. The dependence of the agriculture sector on imported fertiliser is noted to be unsustainable and the PEDSA encourages in-country production and provision of the necessary factors of production. Furthermore, the PEDSA notes that climate change is likely to exacerbate the aforementioned environmental problems as well as other challenges such as reduced rainfall and availability of fresh water. One of the key result indicators of the PEDSA is "*Result 3.2 The capacity of the Ministry of Agriculture, the Ministry of the Environment and other actors (eg NGOs) to analyse and formulate policies and programmes related to land, water, forest and climate change improved*", which contributed to the development of the Action Plan for Climate-Smart Agriculture (described in Chapter 1.3.4 below).

1.3.2 Food Production Action Plan

In June 2008, the government approved the 2008–11 Food Production Action Plan (FPAP) to address the challenge of rising global food prices. The FPAP was established by an inter-ministerial team convened by the GoM to advise on key areas of action (Strasberg and Kloeck-Jenson, 2002). The FPAP shares most of the objectives of the Green Revolution strategy (described in Chapter 1.3.5 below) but differs in that the FPAP was conceived as a short-term plan that started on the 2008/09 agricultural year. As part of the FPAP, the agricultural budget was increased from four per cent to 10 per cent of the total state budget (the 2008 state budget was US$3.5 billion (Mangwiro, 2008), with the objective of minimising the impact of food prices on poor rural communities. The FPAP recognised that access to staple foods for most rural people in Mozambique is largely from home production and this links to access and ownership of land (Strasberg & Kloeck-Jenson, 2002; FFSSA, 2004). The priority actions and investments identified by the FPAP did not include explicit consideration of the impacts of climate change and unsustainable land management practices on the agriculture sector and was primarily focused on addressing pressures related to food production, food security and rural poverty.

1.3.3 Action Plan for the Reduction of Absolute Poverty

The Government of Mozambique's Action Plan for the Reduction of Absolute Poverty for 2006-10 (PARPA II, acronym in Portuguese) elaborated the five-year government Programme and was the main policy and reference document guiding the CFMP, PES and annual budget for the five-year period of implementation. The PARPA framework was an important signal of policy direction and investment priorities, and international donors providing support to GoM generally try to align their activities to the PARPA framework. The PARPA II was mainly focused on poverty reduction objectives with the intention to reduce the incidence of poverty from 54% in 2003 to 45% by 2009 (RoM, 2006). PARPA II was structured as a successor to PARPA I in three

pillars: governance, human capital, and economic development. However, PARPA II differed in that its priorities included greater integration of the national economy and an increase in productivity. Further, the PARPA II recognized the country's dependence on natural resources for subsistence and income and the direct link between the environment and poverty – as a result, the environment was designated as a cross-cutting sector (RoM, 2006). According to PARPA II, the major environmental priorities in Mozambique for the period under analysis included (RoM, 2006):

- sanitation;
- territorial planning;
- prevention of land degradation;
- management of natural resources, including control of fires;
- legal and institutional aspects (i.e. environmental education, compliance of the law and capacity building);
- reduction of air pollution, waters and soils pollutions; and
- prevention and reduction of natural disasters.

While the PARPA II did not include explicit consideration of climate change, the inclusion of inter-related priorities on disaster risk reduction, natural resource management and sustainable land management were all strongly supportive of later initiatives focused on sustainable agricultural practices such as Conservation Agriculture.

1.3.4 Action Plan for Climate Smart Agriculture

One of the outcomes of the PEDSA (described above) was the development and approval of an "Action Plan for Climate Smart Agriculture", which was welcomed as an important progressive step by the MASA. MASA's efforts to support and promote climate-resilient agricultural techniques practised in smallholder farming is mainly focused on strengthening of extension services, knowledge management, and coordination and M&E aspects. The promotion of Conservation Agriculture techniques, building on the investments in demonstration of CA in past projects to date, will be approached with a heavy emphasis on Farmer Field Schools and demonstration in the field. The Action Plan aims to increase the effectiveness and availability of extension services and improve the linkages between research, extension and farmers. The objective of these reforms is to ensure the extension service can be more effective in supporting farmers to develop and adopt climate-resilient agricultural practices such as CA. However, the effective implementation of the proposed Action Plan will require additional efforts beyond the remit of extension services, including inter alia:

- improved management and sharing of knowledge;
- identification of climate risks to agricultural value chains;
- empowerment of communities for sustainable management of natural resources;
- increased security of land tenure; and
- improved availability and accessibility of inputs and technologies for smallholders.

1.3.5 The Green Revolution Strategy

The New Green Revolution Strategy (GRS) was approved in 2007 with the objective of increasing agricultural productivity, including within the smallholder farmer sector, in a competitive and sustainable way. The GRS proposed the achievement of this objective through promoting sustainable use of natural resources, and improving the accessibility of new technologies, market information, training and financial services. The GRS is also meant to promote the development of local agriculture and forestry-based processing industries (Mucavele, 2009). The GRS approach intends to promote plans and investments that favour small-scale farming households over large-scale commercial producers, in contrast with the PEDSA and PNISA

which primarily support the development of the largescale and commercialised agribusiness sector and associated value chains.

1.3.6 Strategic Plan for Livestock

Livestock has an important place in the livelihoods of small and medium producers in Mozambique. In 2008, analysis of the annual agricultural survey indicated that 58.8% of small and medium producers had chickens, 26.2% had goats, 12.1% had pigs, 11.4% had ducks, and 6.7% had cattle (GoM, 2008). The livestock sector made up 10 percent of total agricultural production but contributed only 1.7 percent of GDP in 2008 (OIE, 2008). The GoM (2004) also reported that the industry was decimated by the war and it is estimated that of the 140,000 farmers that owned cattle in that period, there were only 340 of medium-to-large-scale producers which were market-orientated. In 2000, VETAID reported that the distribution of cattle by zones were 51.1% in the southern area, 44.1% in the central area and only 4.8% in the northern area. It further reported that this distribution tendency has changed since 1980 with a higher proportion of cattle currently in the central zone and a greatly reduced number in the south. Partly this is because many of the southern cattle were the property of big companies which have since disappeared, while the major owner of cattle in the central area, mainly in Tete province, are kept by small-scale farmers (family sector) (VETAID, 2000).

The Strategic Plan for Livestock did not include any provisions or explicit consideration of the potential impacts of climate change, nor on the possible role that livestock could play in increasing household resilience to climate change. In addition, the tendency to view crop agriculture and livestock husbandry in different 'silos' or policies results in the limited consideration of animal draught power as a potential contributor to crop agriculture, where harnessing of plough animals can potentially reduce the labour requirements for preparation of larger areas of land compared to hand-hoed fields. Therefore, there is a gap in Mozambique's policies and actions for the agriculture sector which does not recognise the possible synergies between promotion of livestock husbandry and upscaling of the Conservation Agriculture approach using animal draught power.

1.3.7 Land Law

The 1997 Land Law advocates that communities could convert their freehold rights into the Right to Use and Exploit Land (DUAT, acronym in Portuguese) through which the state grants rights for land use and benefit and it also recognise rights acquired by customary occupation as equivalent to the State Land Use and Benefit Right, or DUAT (GoM, 1997). DUAT is a state-granted land right and is Mozambique's single form of land tenure right. It is exclusive, inheritable and transmittable. Irrespective of the means it was acquired, the resulting DUAT right is exactly the same. DUAT can be recognised by recognition of long-standing occupancy. It can be granted either by: (i) customary traditional occupancy, (ii) good faith occupation and (iii) award on a concessionary basis (Norfolk and Tanner, 2007). The Constitution established a legal framework in the 1997 Land Law which contains several innovative approaches to achieving these goals, these include:

- establishment of a single form of land tenure right, the DUAT, irrespective of the means through which it is acquired;
- recognition in law of DUATs obtained through customary and good faith land occupation;
- protection in law of DUATs obtained through customary and good faith occupation of land without the need for their formalization and registration;
- provision of a flexible approach to proving and spatially defining DUATs acquired through customary and good faith occupation; and

- establishment of the right (and obligation) of local rights holders to participate in land and natural resources management and land rights allocation processes (Norfolk and Tanner, 2007).

All land in Mozambique was nationalized at Independence in 1975 under a socialist Constitution. This post-Independence DUAT was more a reflection of the principle that land belongs to he (or she) who works it, than a recognition of some private hold over land. DUATs acquired in this way are held in perpetuity, and need not be surveyed or registered. Most rural land in Mozambique is occupied by communities holding customary DUATs, and is used for multiple purposes including residency, infrastructure, social reproduction, crops, livestock grazing, forest resources, and reserved land for future generations (GoM, 1999). The land use rights (DUATs) are equivalent under the law, and delimitation of the landholding and registration of the DUATs creates a public record of the individual plots and help farmers qualify for investment loan. DUATs obtained by occupancy are perpetual and do not require plans for exploitation of the land. Delimitation and registration is voluntary: communities are not required to delimit or register their land to assert their DUAT. However, pursuant to a 2008 resolution, if local communities want to register their DUAT, they must prepare an exploitation plan. Members of local communities can also obtain DUATs for individual plots within the community land. Local communities can also grant third parties, such as investors, rights to use land within their territories (GoM, 1997; Akesson, Calengo and Tanner, 2009).

The significance of the Land Law to Mozambique's efforts to promote CA is that the Law provides adequate security of tenure for the occupying farmer to invest in practices such as CA which may take several years to yield returns. In the absence of secure land tenure, farmers may be reluctant to invest in expensive or labour-intensive strategies that may only generate returns some years later, particularly if there are no assurances that the farmer can claim rights to occupy and use the land.

1.4 Alignment of Mozambique's policy frameworks for climate change and agriculture, respectively, in support of climate-smart agriculture and conservation agriculture

The gradual revisions and updates of Mozambique's institutional and legal framework have resulted in increasing harmony between the cross-sectoral priorities on climate change and sector-specific actions in the agriculture. As a result, considerations of climate change, including strategies to adapt to and mitigate against climate change, are well integrated into the country's strategic actions for the agriculture sector. Similarly, at a cross-sectoral level, the policy framework to guide Mozambique's responses to climate change includes detailed considerations of the potential impacts and adaptation strategies for the agriculture sector. Figure 1, below, illustrates the most important current measures in Mozambique's policy framework to support integration of climate change into the agriculture sector, from the level of international commitments down to field-level implementation of adaptation measures.

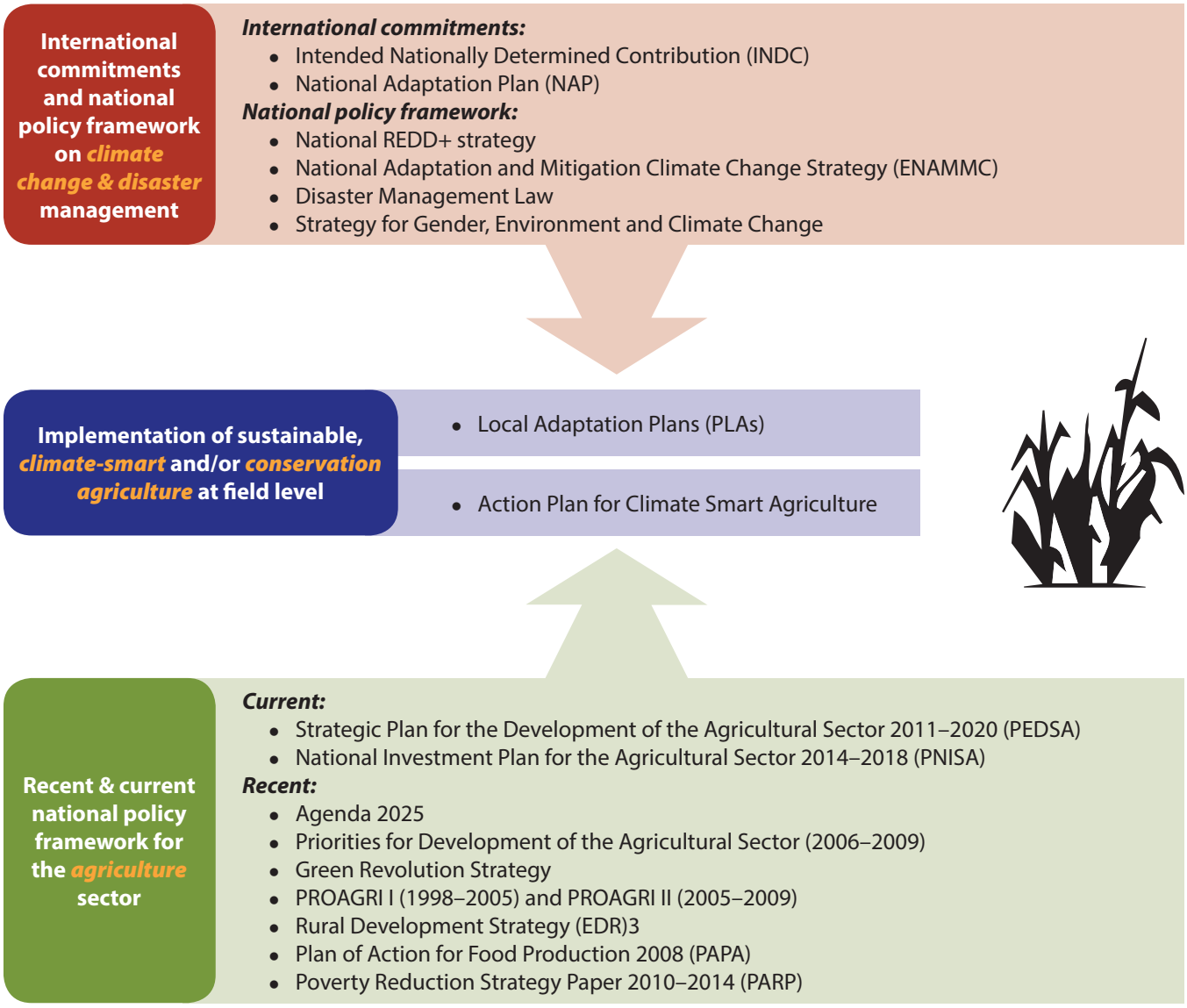


Figure 1 Alignment of Mozambique's policy frameworks for the agriculture sector and national responses to climate change

1.4.1 Coordination of planning and budgeting processes for agriculture from national to district levels

The abovementioned list of policies and strategies, while not completely comprehensive, provides an overview of the main features of the policy framework which enable the implementation of sectoral and cross-cutting actions on climate change (particularly within the agriculture sector). The implementation of the strategic priorities is based on the development and budgeting of annual operational plans within each of the ministerial mandates at national, provincial and district levels.

At the cross-cutting level, the annual State budget is comprised of balanced budgetary needs across all areas of public investments and services, including the requests for Ministerial budgets from each of the line Ministries. The Ministry of Economy and Finance (MEF) have co-responsibility for planning and budgeting. The national planning process under the responsibility of MEF is based on long-term global and regional development agendas (e.g. SDGs, the SADC development vision and the national long term vision outlined in the Agenda 2030). Together, these agendas help frame the government mid-term planning through the

Five Year Government Plan (Plano Quinquenal do Governo, PQG).

At a national sectoral level, MASA's annual activities are scheduled and budgeted through the preparation of the Annual Action Plan in Agriculture (PAAO), which is based on the collation of contributions from MASA offices at the provincial and district levels. The budget requests generated at the district- and provincial-level are formalised in the annual National Socio-Economic Plan (PES), which is itself composed of provincial-level submissions. The national PES is submitted to the Council of Ministers for approval before it goes to the parliament for the final endorsement. At the province-level, each provincial government prepares an annual Socioeconomic Plan (PESP), which is informed by the provincial priorities and activities proposed by the various district-level plans. The latter district-level priorities are established within the 10-year District Development Plan (PEDD) and the annual district Socio-Economic Plan (PESOD), which are approved by the District Consultative Council (CCD). District proposals are prepared after a consultation process with the local authorities to identify local priorities, vulnerabilities and opportunities. District proposals are finally submitted to, and evaluated by, provincial authorities to be integrated into national PES and sectoral plans.

In principle, the development of national-level budgets within the PES and PAAO are based on a bottom-up approach that incorporates district-level priorities into provincial, and subsequently national, priorities. As a result of the substantial contributions of the international community to Mozambique's State budget, the preparation of PES and PESOD priorities includes extensive consultation with bilateral and multilateral development partners, who provide support either directly to the government budget (budget support), to a particular sector or to particular projects and programmes.

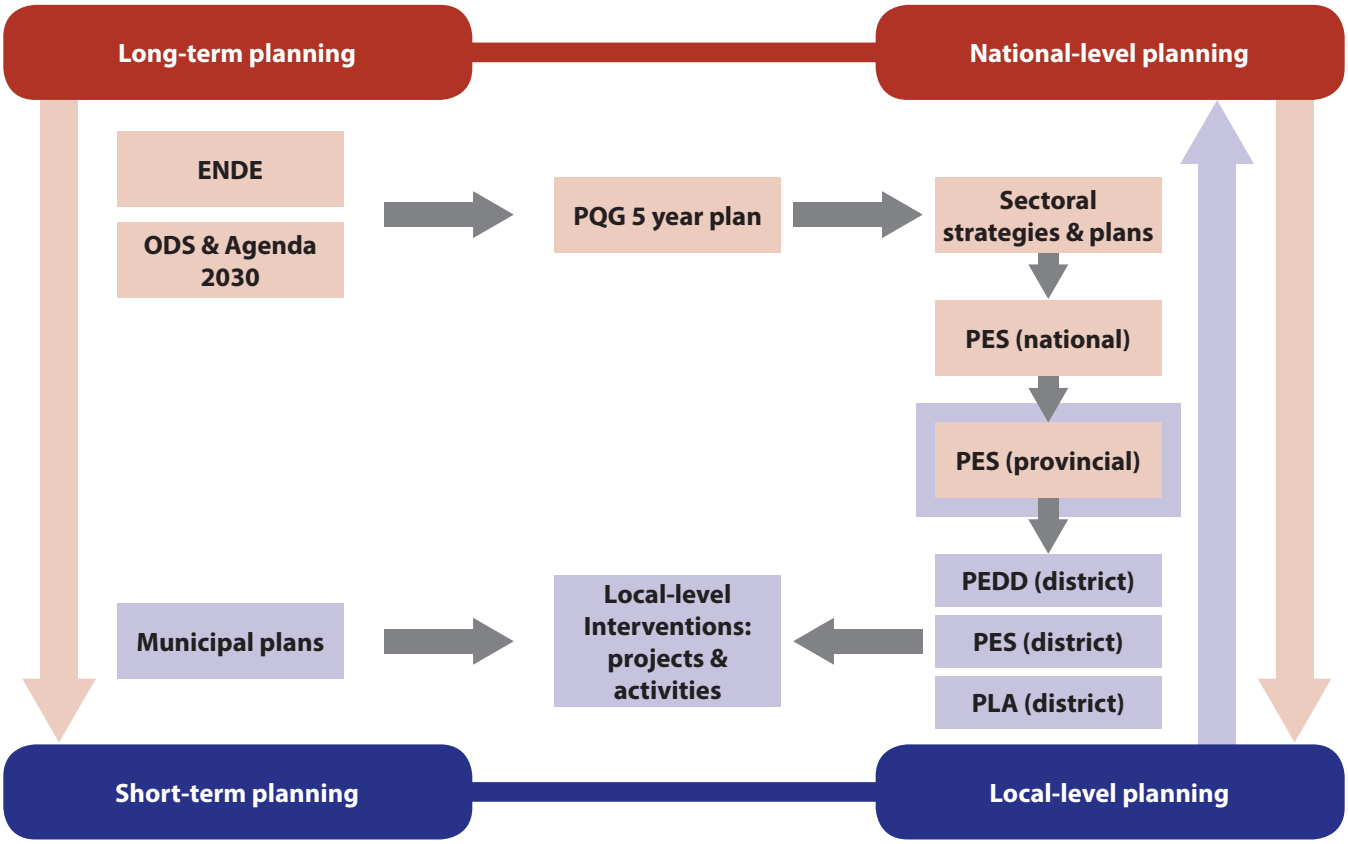


Figure 2 Alignment of Mozambique's budget and planning processes from national to local levels

2 Institutional Arrangements, Coordination and Leadership on Climate Change

As a result of the cross-cutting nature of the causes and impacts of climate change, there are number of Ministerial actors working in coordination on issues related to climate change. However, a challenge to the effective coordination and monitoring of actions on climate change is the ongoing restructuring and realignment of key ministries, departments and directorates. As a result of the rapid changes in Mozambique's governing institutions, there is a lack of updated descriptions of the institutional framework for the national response to climate change. The coordination of the various governmental portfolios and investments related to climate change is overseen by the Inter-Institutional Group for Climate Change (GIIMC) (described further below in Chapter 2.2). The MITADER has the primary responsibility for all matters related to climate change and environment, with a strong emphasis on cooperation with other ministerial portfolios such as agriculture, water, energy, meteorological sciences and socio-economic development (described in Chapter 2.3 to 2.8, below). A diagram is provided to map the coordination structures between all public stakeholders participating in climate change adaptation in the agriculture sector in Chapter 2.1, below.

2.1 Coordination and alignment of institutions working on climate change adaptation in the agriculture sector

Mozambique's sectoral and cross-cutting strategies for climate change are implemented by stakeholders from several line ministries in varying degrees of collaboration and cooperation. The mandate of MITADER to lead the implementation of the ENAMMC strategy through the designated Climate Change Department in the National Directorate for Environment places this ministry at the centre of the country's climate change response, with the responsibility to work in alignment with a diversity of governmental and non-governmental stakeholders. Figures 3 and 4, below, provide a diagrammatic representation of the arrangement of the key ministries and the subordinate line departments that are actively participating in the country's climate change adaptation responses, with a particular emphasis on adaptation in the agriculture sector.

In the current institutional framework, implementation of the national climate change response is led by MITADER's Climate Change Department, who is mandated under the national ENAMMC strategy to report on progress made through the M&E framework of the SNMAMC. At a sectoral level, including within the agricultural and DRM sectoral frameworks, MITADER's responsibilities towards the country's climate change response are undertaken in participation with the relevant mandated line ministries or departments using the platform of the GIIMC council to coordinate and align priority activities. The framework for inter-governmental coordination of Mozambique's climate change response depicted in Figures 3 and 4 is the primary mechanism for engagement with implementation partners such as NGOs and CBOs, bilateral and international development partners, academia and civil society.

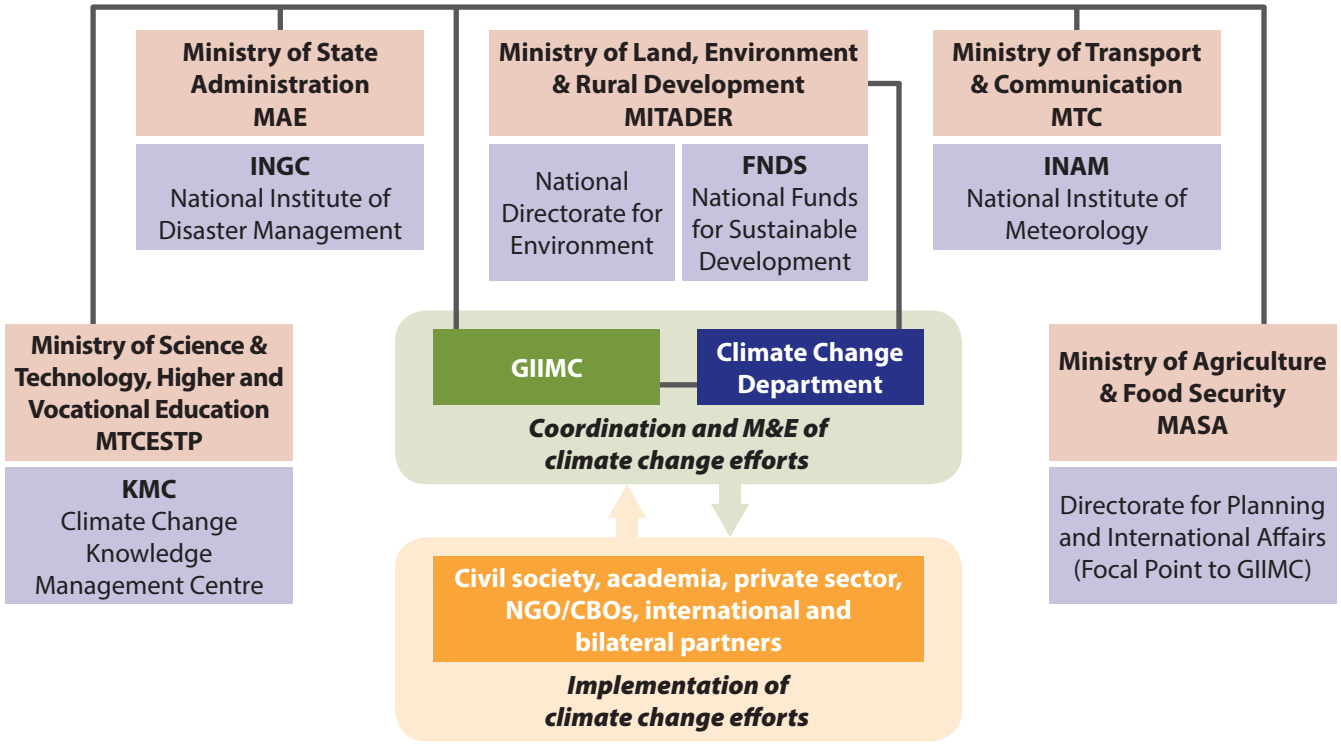


Figure 3 Summary Institutional Map of Governmental Stakeholders Participating in Climate Change Adaptation in Mozambique's Agriculture Sector

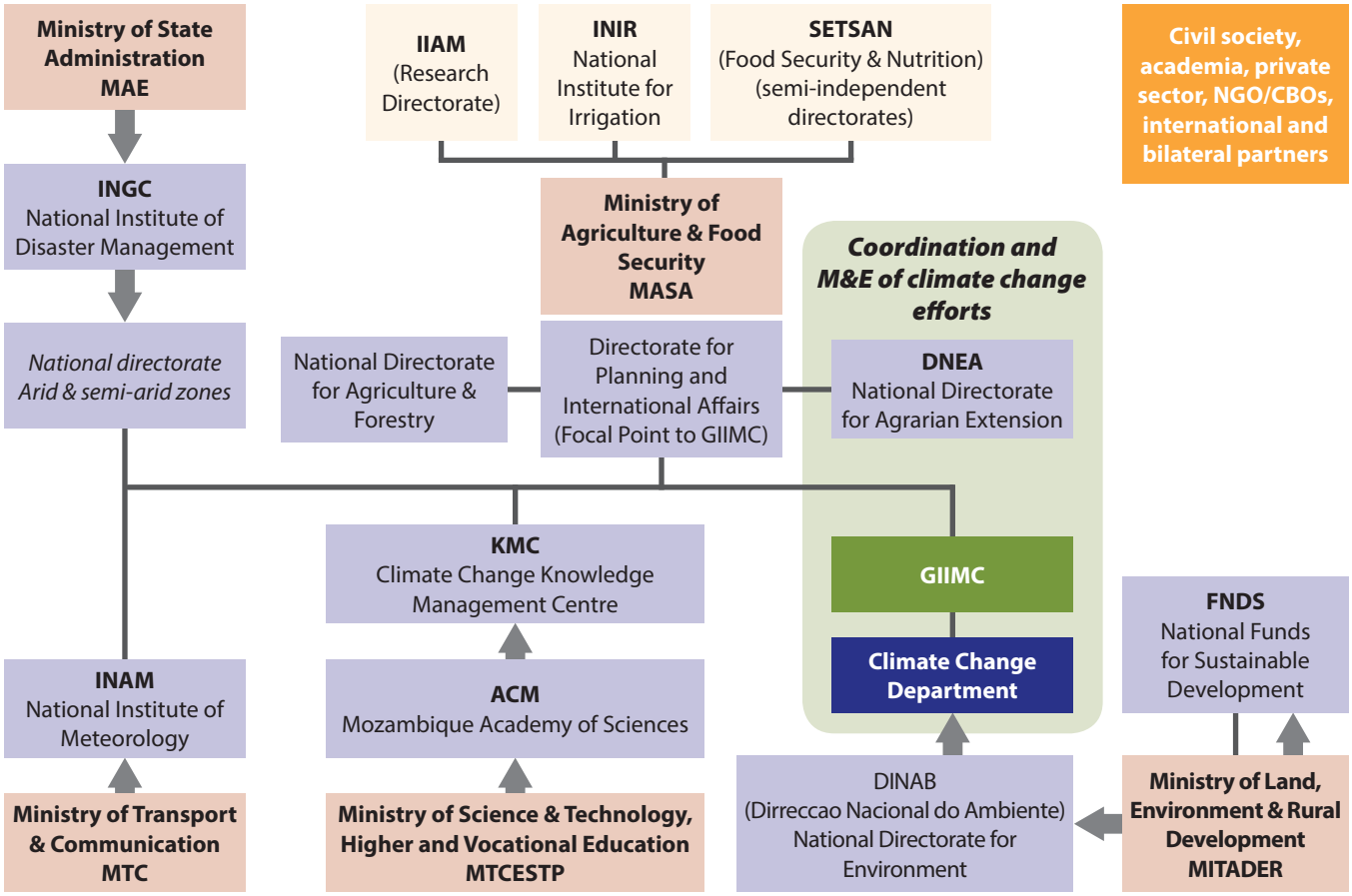


Figure 4 Detailed Institutional Map of Governmental Stakeholders Participating in Climate Change Adaptation in Mozambique's Agriculture Sector

2.2 The Inter-Institutional Group for Climate Change

The Inter-Institutional Group for Climate Change (GIIMC, acronym in Portuguese) is a critical body for coordination of all climate change-related stakeholders and initiatives in Mozambique. The platform provided by the GIIMC serves to provide oversight to ensure the relevance and alignment of proposed initiatives, to promote collaboration between stakeholders and initiatives with complementary activities, and to prevent duplication of efforts between two or more stakeholders working in similar themes/areas. The role of the GIIMC as a coordinating body is critical in the context of cross-cutting themes that overlap between the mandates of multiple stakeholders, particularly while Mozambique's institutional and policy framework is currently in a state of partial revision. However, despite the strategic importance of a stakeholder to chair the country's climate change responses and activities, at present GIIMC has no formal responsibility or mandate and mainly serves advisory functions. One of priority actions (out of six) of the ENAMMC in the pillar on cross-cutting issues is to adjust and align the existing institutional framework with the CC strategy from which it is expected to create the GIIMC statutes making it a formal entity that will guarantee the full functioning of the Climate Change Network. According to ENAMMC, the activities developed by the future CC knowledge management entity are of a National scope and should be carried out based on the Climate Change Network.

A recent study report (UNDP-MITADER, 2017) indicates that the Climate Change Network is currently composed by 12 thematic areas: (i) coastal zones, fisheries and tourism; (ii) climate modelling; (iii) communities and local knowledge; (iv) water resources; (v) biodiversity and ecosystems; (vi) human health; (vii) food and nutrition security; (viii) agriculture, livestock and forestry; (ix) cities; (x) energy; (xi) industry; and (xii) economics and finance. The ENAMMC foresee the creation of new thematic areas, whenever necessary. Until recently, the role played by GIIMC in oversight of national climate change-related actions was partly superseded by the now-defunct National Sustainable Development Council (CONDES, acronym in Portuguese). The CONDES Secretariat was created by the Environment Framework Law as an advisory body to cabinet on public matters of the environment and sustainable development, with the aim to coordinate and integrate sustainable environmental management into the country's development process. Prior to dissolution, CONDES was chaired by the Prime Minister and included representation from other members of cabinet and civil society. In the current institutional framework, the former responsibilities of CONDES are now mainly within the mandate of MITADER, which is now chiefly responsible for monitoring and reporting on progress towards sustainable environmental management in general and climate change in particular.

2.3 Ministry of Land, Environment and Rural Development

The Ministry of Land, Environment and Rural Development (MITADER, acronym in Portuguese) was established in 2014, replacing the environmental ministry formerly known as MICOA (Ministry for Coordination of Environmental Affairs). The former MICOA ministry was established in 1994 with the broad mandate to manage the country's natural resources and was responsible for coordination, advice, control and evaluation of natural resources in Mozambique. In addition, MICOA was responsible for coordination of the sustainable development goals in line with international standards and was also mandated to develop appropriate and effective policies and laws to preserve the environment.

The recently established MITADER is an amalgamation of three former public institutions, namely MICOA and the former Institutes for

Land and Rural Development, which consolidates responsibility for land management, rural development, environmental regulation and protected areas management. MITADER is also responsible for monitoring compliance with obligations under the UNFCCC and other Rio conventions. The ministry works closely with the Ministry of Agriculture and Food Security (MASA) through the Technical Secretariat for Food Security and Nutrition (SETSAN – the body responsible for coordinating the implementation of the National Food Security and Nutrition Strategy), the Ministry for Foreign Affairs, and through the Institute for Disaster Management (INGC) (all described further below). These institutions integrate several inter-institutional groups led by MITADER whose main task is to impel the implementation of existing legislation and actions. MITADER (and formerly MICOA) has developed a number of instruments and strategies to promote environmental sustainability and climate resilience, including *inter alia*:

- Environmental Law (1997);
- Environmental Strategy for Sustainable Development (2007);
- Action Plan for Prevention and Control of Soil Erosion (2007);
- Action Plan for the Prevention and Control of Uncontrolled Burning (2007);
- National Action Plan to Adapt to Climate Change (2007–2010); and
- National Climate Change Adaptation and Mitigation Strategy (2012) for the period 2013–2025 (Silici, Bias, and Cavane, 2015).

2.3.1 National Directorate for Environment

The National Directorate for Environment (DNE, acronym in Portuguese) is MITADER's main focal point to the national climate change secretariat (GIIMC) and therefore plays a key role of coordination and leadership of national responses to climate change. As a result of the recent institutional restructuring within the public institutions working on climate change, the responsibilities for coordination and implementation of national priorities have shifted. Until recently, prior to the establishment of MITADER, a cross-governmental Climate Change Coordination Unit (UMC) was responsible for the coordination of climate change agendas across government. This unit was hosted by the now-defunct CONDES during the implementation of the SPCR programme which focused on climate change policy reforms, climate change knowledge sharing and PPCR pilot investments monitoring and reporting (CONDES, 2015). The UMC was established within the CONDES Secretariat after the establishment of the ENAMMC strategy, and was responsible for reporting progress on climate change efforts to the GIIMC as the primary body for coordination of government actors working on climate change. The UMC also provided technical advice on projects and programs relating to climate change and development and is intended to facilitate cross-institutional working and information-sharing.

At the present time, the roles of the UMC have now largely been moved to the Climate Change Department within MITADER's DNE. The Climate Change Department is mainly guided by the aforementioned ENAMMC as the main strategic guide for Mozambique's ongoing responses to climate change, and MITADER plays a role of oversight in monitoring national progress towards key climate change in coordination with sectoral ministries (monitoring and evaluation of implementation of the SNMAMC framework is aligned with the priorities established in the ENAMCC.

The development of Local Adaptation Plans (PLAs) is one of the primary means by which the ENAMMC aims to integrate adaptation planning into local-level activities and strategies for management of land use. The development of PLAs was initiated on a pilot basis in ~2013, led by the former ministries MICOA (now MITADER) and the former Ministry of Planning and Development (MPD). Central-, provincial- and district-level

staff of the newly-restructured MITADER were provided with training on themes such as Climate Vulnerability Capacity Assessments and elaboration of PLAs in participation with communities. A Methodological Guideline on Elaboration of Local Adaptation Plans (PLAs) was prepared and piloted in 2014, since which time PLAs for over 50 districts have been drafted or approved for implementation (the majority of these districts being concentrated in the South of the country). It is anticipated that the future focus of MITADER's field-level activities to promote climate change adaptation initiatives will emphasise the replication and upscaling of the LPA process in Central and Northern districts. The latter initiative provides an opportunity to integrate principles such as CA and other forms of CSA into local-level land planning, in alignment with strategic frameworks for climate change and agricultural development.

2.3.2 National Fund for Sustainable Development

The National Fund for Sustainable Development (FNDS, acronym in portuguese) is a strategic fund overseen and managed by MITADER to promote and finance programs and projects to ensure sustainable, harmonious and inclusive development. The FNDS replaced the National Fund of Environment (FUNAB, acronym in portuguese) which was previously in effect while continuing to provide strategic funding for similar initiatives related to environment, natural resources and climate change. FUNAB and FNDS initiatives were created to promote improved environmental management and to provide contingency support in case of accidents or environmental damage. These funding mechanisms exist to support the country in promoting a healthy environment; achieving a high quality of life and balancing issues of environment with socio-economic development (CONDES, 2014).

The primary activities of FNDS include:

- support activities of management of natural resources that contribute to a more healthy environment at the local level, including the fight against erosion and desertification;
- contribute to the promotion of activities related to the management of areas of environmental protection, rehabilitation or restoration of degraded areas;
- support the implementation of technical and scientific activities for the introduction of technologies and best practices for sustainable development;
- promotion of activities related to environmental impact assessment and other activities related to assessment of environmental impacts resulting from actions or development activities;
- contribute to the achievement of economic enterprises wishing to use the technology and environmentally sound production processes; and
- develop financing mechanisms to support environmental management and maintenance.

It is anticipated that FNDS will play an increasingly important role in publicly-financed initiatives on climate change, sustainable resource use and other related themes.

2.4 Ministry of Agriculture and Food Security

The ministerial mandate for Mozambique's agriculture sector has undergone changes in recent years, with the restructuring of the former Ministry of Agriculture (MINAG, *acronym in portuguese*) to become the recently established Ministry of Agriculture and Food Security (MASA, acronym in portuguese). In January 2015, Presidential Decree No. 1/2015 established MASA as the central body responsible for organizing and ensuring the implementation of legislation and policies in the field of agriculture, livestock, irrigation, agro-forestry and food security (INE, 2016).

MASA is mandated to establish strategies

to ensure food and nutritional security of the population. In addition, the ministry is responsible for production and publication of official agricultural statistics in its various directorates and agencies (such as the *Trabalho de Inquerito Agricola* or Annual National Agricultural Survey, discussed in Part III of this technical report). However, some statistical programs are jointly organized and conducted by both the National Institute of Statistics of Mozambique (INE) and MASA (INE, 2016). As a result of the cross-cutting nature of the agriculture sector, the implementation of MASA's policy framework is based on an approach of inter-sectoral coordination regarding the formulation, monitoring, evaluation and implementation of policy actions.

As described previously in Chapter 1 (above), MASA's priorities are informed by several key policies and strategies, including the FPAP, PARPA and the PEDSA. In terms of climate change-specific priorities, MASA's activities are aligned with cross-cutting national policy instruments such as the ENAMMC strategy and the SNMAMC monitoring framework (which includes multiple objective indicators for adaptation in the agriculture sector) and the sectoral priorities outlined in the draft Action Plan for Climate Smart Agriculture.

The diverse responsibilities and mandates of MASA are overseen by several directorates and departments, including *inter alia* *Inspectorate*-General for Agriculture and Food Security; National Directorates for Agriculture and Silviculture; National Directorate for Veterinary; National Directorate for Agricultural Extension; Directorate for Documentation of Agrarian Information; and Directorate for Planning and International Cooperation .

In addition to the abovementioned 'line' directorates, MASA's activities are further supported by subordinate institutions for research and development activities (notably the *National Institute for Agricultural Research of Mozambique* (IIAM) and dedicated facilities for development of cotton and cashew crops) and sponsored institutions such as Agrarian Development Fund (FDA); National Institute of Irrigation (INIR); Technical Secretariat for Food and Nutritional Security (SETSAN).

2.4.1 National Directorate of Agricultural Extension

The National Directorate of Agricultural Extension (DNEA, acronym in Portuguese) is a critical actor in MASA's activities to increase the productivity and food security of the smallholder agriculture sector. DNEA is responsible for operation of the Unified Extension Service (SUE, *acronym in portuguese*) and the National Extension System (SISNE, *acronym in portuguese*) across the entire country, often in collaboration with private sector and non-governmental partners. The national extension system aims to develop, promote and disseminate appropriate technologies, crops and approaches to smallholder farmers according to local needs. An explicit part of DNEA's mandated responsibility is to "coordinate the implementation and dissemination of good practices adapted to climate change that contribute to the sustainable use of natural resources", which includes a strong emphasis on climate-smart agricultural practices such as CA. Under the ongoing institutional reforms within MASA, the DNEA is currently structured around four units for Farmers Organisations, Communications, Training, and Technology Development, respectively. An addition to the DNEA proposed by the 'Action Plan for Adaptation to Climate Change' is the inclusion of a dedicated extension unit for climate change adaptation.

DNEA's field activities are primarily driven by the National Programme for Agricultural Extension (PRONEA) with support of international and local development agencies and NGOs. PRONEA was established to operationalize the Agricultural Extension Master Plan developed by the former MINAG ministry. The PRONEA programme is aligned with the existing strategic framework for the agriculture sector, including the Green Revolution Strategy (GRS), Agricultural Programme for Food

Production (PAPA), and the Agricultural Sector Development Strategy (PEDSA, 2011 -2020). The main principles of the current PRONEA programme are based on decentralisation of extension governance and implementation to the district level with increased involvement of farmers in the design and selection of farming approaches. The PRONEA programme is also intended to emphasise increased economic and social empowerment of farmers through increased participation in, and improvement of, agricultural value chains. Approximately 1,350 field extension workers are employed by MASA, however the number of extension workers employed per district is highly variable.

2.4.2 Technical Secretariat for Food and Nutrition Security

The Technical Secretariat for Food and Nutrition Security (SETSAN, acronym in Portuguese) was established in 2010 under MASA with the mandate to promote and coordinate activities to assure Mozambique's food security and nutrition. In this capacity, SETSAN is responsible for coordination at the institutional and interministerial level to implement the country's strategic actions related to food security. In addition, SETSAN is responsible for monitoring the country's food security status and evaluating progress towards objectives related to food security and nutrition, and to coordinate actions for timeous and effective intervention in cases where food insecurity can be observed or forecast.

2.4.3 National Irrigation Institute

The National Irrigation Institute (INIR, acronym in Portuguese) is a public institution created under Decree no. 9/2012, of 11 May. It was created by the Council of Ministers comprising of the legal personnel with technical and administrative autonomy. It is under the Ministry of Agriculture. INIR's mandate is to oversee agricultural issues by ensuring efficient and sustainable planning, development, use and management of land and water resources for agricultural production (National Institute of Irrigation, INIR, undated).

Its projects under INIR are funded by GoM, AfDB, WB and partnership governments such as the Government of Netherlands and Japan. These projects include *inter alia*:

- Increase Water Productivity for Irrigation in Mozambique, Tanzania and Zimbabwe through the Agricultural Monitoring, Management Adaptation and Agricultural Innovation Platforms;
- Project on Flood Control, Irrigation and Drainage-Munda Munda;
- Sustainable Management of Land and Water Resources;
- Project for development of Sustainable Irrigation-PROIRRI; and
- Irrigation and Climate Resilience in the Lower Limpopo.

2.4.4 Agricultural Research Institute of Mozambique

The Agricultural Research Institute of Mozambique (IIAM, acronym in Portuguese), a subordinate institution of MASA, is Mozambique's primary agricultural research institution. IIAM is mainly focused on research and development to support the productivity and efficiency of Mozambique's agriculture sector, particularly through generating local-level and timeous research products to inform stakeholders across the agricultural value chain. IIAM is also responsible for communication of pertinent technical information to relevant stakeholders in the agriculture sector, from government policy-makers to field-level extension workers and farmers. INAM's research focus includes agronomic, forestry and animal sciences, rural sociology and economics and agro-business, which is undertaken with the objective of providing scientific, technical and administrative guidance to MASA and other public institutions involved in the agriculture sector.

IIAM has four technical directorates:

- Directorate of Agriculture and Natural Resources (DARN);
- Directorate of Animal Sciences (DCA);
- Directorate of Training, Documentation, and Technology Transfer (DFDTT); and
- Directorate of Planning, Administration and Finance (DPAF).

In terms of contribution to research on Conservation Agriculture, the work undertaken by IIAM as part of the Food Security Group led by Michigan State University has undertaken and published a large body of research into the implementation, effectiveness and impacts of Mozambique's CA initiatives (http://fsg.afre.msu.edu). Another significant research contribution by IIAM is the contributions towards the annual National Agricultural Survey, also known as Agricultural Enquiry Work (TIA) which surveys smallholder farmers on topics such as crop choices, yields obtained, inputs applied as well as assorted demographic and socio-economic information. The latter survey (described further in Part III of this technical report) does not include explicit questions on the use of Conservation Agriculture techniques, however the survey does gather information on farmers' preferences for using various improved inputs such as herbicide, manure and fertiliser (which can be viewed as a proxy for adoption of CA in the sense that use of improved inputs is indicative of adoption of an alternative approach to traditional agriculture).

2.4.5 Directorate for Planning and International Affairs

MASA's Directorate for Planning and International Affairs (DPCI, acronym in Portuguese) exists to coordinate MASA's activities from central down to district-level in alignment with the complex institutional and legal framework that guide's that Ministry's mandates. The Directorate acts as a focal point to coordinate within MASA's directorates as well as between other government agencies to formulate effective guidelines, policies and strategies in the various areas of activity of interest. In line with this cross-cutting role in implementation of governmental policy within MASA, the Directorate for Planning and International Cooperation serves as MASA's focal point to the GIIMC to maintain close collaboration and cooperation with other ministries and government departments working on climate change. Furthermore, this Directorate's active participation in GIIMC is in line with the mandate to coordinate the implementation of Mozambique's international commitments and agreements under the UN's Rio Conventions as well as participate in the negotiation of bilateral and multilateral agreements on behalf of the Ministry. As a result of the prominent role played by this Directorate in the coordination and implementation of MASA's activities, including within national as well as international/multilateral initiatives, it is anticipated that the Directorate for Planning and International Cooperation will be an important stakeholder for future initiatives with a cross-cutting focus on agriculture and climate change.

2.5 Ministry of Economy and Finance

At the start of 2015, the Ministries of Finance (MF, acronym in Portuguese) and of Planning and Development (MPD, acronym in Portuguese) were merged into the Ministry of Economy and Finance (MEF, acronym in Portuguese). MEF is responsible for managing national development and is the focal point for management of external finance and related projects. In addition, the National Directorate for Monitoring and Evaluation within MEF is the National Designated Authority for Mozambique's communications with the Green Climate Fund (GCF) and is therefore anticipated to play an important role in applying for and managing external finance to support climate change-related initiatives through the latter fund.

Although the recently established MEF does not have a long track record of leadership on Mozambique's climate change response, the former MPD which preceded the current administration was instrumental in facilitating the consideration of climate change in the country's revised institutional and policy frameworks through the implementation of the Climate Change Development Policy Operation (DPO) project in Mozambique. The DPO series aimed to address challenges that relate to inclusive growth and poverty reduction by strengthening the institutional and policy framework needed for integrating climate change issues into development policies at national and sectoral levels. The approach of the DPO series was based on the establishment of a set of policy instruments to mainstream climate change considerations into sectoral strategies across all spheres of government through the SPCR programme (World Bank, 2014). The first pillar of the SPCR delivered by the SPCR was a set of institutional, policy and budgetary reforms to integrate considerations of climate change across multiple productive sectors, including agriculture (Republic of Mozambique, 2011).

Institutional reforms targeted by the SPCR included *inter alia* (KMC, 2015b):

- national climate change strategy (which was established as the ENAMCC);
- climate change M&E framework (which was established as the SNMAMC);
- revised disaster risk management policy; and
- climate change adaptation plan for the agriculture sector (established as the abovementioned Climate Change Action Plan).

In addition to the widespread institutional reforms catalysed with the technical assistance of Mozambique's PPCR partners, a number of ambitious pilot projects were implemented under the second pillar of the SPCR project. The latter projects were designed by the former MICOA and MPD ministries (now MITADER and MEF, respectively) and implemented in participation with the World Bank (WB), African Development Bank (AfDB), and the International Finance Corporation (IFC) among others. Themes and sectors covered by these largescale SPCR pilot projects included:

- strengthening of hydro-meteorological services in the project "Transforming Hydro-Meteorological Services Project for Mozambique" (HYDROMET);
- increased climate-resilience in coastal cities and towns in the "Cities and Climate Change" project (CCCPP);
- maintenance, rehabilitation and upgrading of climate-vulnerable road infrastructure in the "Roads and Bridges Maintenance and Management Programe" (APL-II);
- restoration of natural capital and water management infrastructure in the project "Sustainable Land and Water Resources Management" (SLWRMP); and
- promotion of climate-resilient agriculture through development of irrigation infrastructure and strengthening of agricultural value chains through the project "Baixo Limpopo Irrigation and Climate Resilience Project" (BLICRP).

The MEF has played an important institutional role in the formulation and financing of the abovementioned projects and as a result has become an important stakeholder in national-level projects focused on climate change, despite not playing a major role in the implementation of field-level activities. The inclusion of MEF on the cross-cutting body for coordination of national climate change affairs, the GIIMC, reflects the importance of the role played by MEF in collaborating and coordinating between stakeholders.

2.6 National Institute of Meteorology

Mozambique's National Institute of Meteorology (INAM, acronym in Portuguese), formerly known as the Mozambique Meteorological Service is hosted by the Ministry of Transport and Communication.

INAM is mandated to provide meteorological information to support improved planning, as well as to provide early warnings where necessary to minimise risks to life and property (Duvane, 2014). INAM provides several different forecasts and meteorological products through the year including *inter alia* daily and seasonal weather forecasts, weather and climate observations, and specialised forecast products for the aviation and marine sectors. Public forecasts issued by INAM include three daily forecasts – two '24-hour' forecasts issued in the morning and afternoon, respectively, plus one 'four day' forecast issued every morning (Duvane, 2014).

In addition to the daily forecasts which are broadcast via media such as national news and INAM's website, the Institute prepares seasonal agricultural forecasts for each province which are presented at the start of agricultural season, usually in September (i.e. the weeks prior to the onset of the rainy season when farmers begin to prepare their lands). The latter seasonal forecasts (discussed further in Part III of this technical report) are presented publicly by INAM officials, usually at a public building in the relevant provincial capital, where agricultural stakeholders such as farmers unions and clubs, extension officers and NGOs are invited to attend. In general, the delivery of seasonal forecasts for Mozambique's provinces begins with an annual regional meeting via SADC's "Regional Climate Outlook Forum", followed by a national-level briefing at the "National Climate Outlook Forum" (the latter forums are open to other concerned stakeholders such as INGC, MASA and the Water Resource Management Directorate), before seasonal forecasts are issued at the sub-national level. The seasonal forecasts are delivered by INAM staff within each River Basin at public meetings arranged by local representatives of the Water Resource Management Directorate.

Despite GoM's recognition of the strategic importance of providing updated and accurate climate information services to sectors such as aviation, agriculture and maritime services, there are fundamental structural and capacity challenges which undermine the effectiveness of INAM's activities and prevent the widespread use of meteorological information in the country. In an analysis of the meteorological services in Mozambique, Manhique (2011) noted that constraints on INAM's sustainability and funding mechanisms included:

- inadequate allocation from budget;
- high dependence of state budget on foreign aid;
- lack of mechanisms for income generation through provision of climate services;
- limited consideration of meteorology in country development policies;
- inadequate capacity for ongoing maintenance of equipment;
- government salaries are inadequate to attract skilled professionals.

Although INAM has proposed the development of regional forecasting centres and concomitant development of the meteorological monitoring network, at present most monitoring stations are located in the South and/or Coastal zones of the country and there are inadequate funds to support the investment and maintenance costs of the proposed upgrades to the monitoring network. As a result of the limited and spatially-variable coverage of INAM's network of meteorological stations across Mozambique's heterogeneous landscape, the daily and seasonal forecasts are considered to be unreliable in many areas. In addition, as a result of the specific needs of Mozambique's rainfed agriculture sector for climate information that includes accurate advanced warning of the onset of the rainy season, there have been instances where seasonal forecasts have been too late or insufficiently accurate to be used by farmers. As a result, there remains a relatively low level of awareness and uptake up of official INAM forecasts by smallholder farmers, the majority of whom still tend to rely on traditional and/or informal sources of knowledge to plan the upcoming agricultural season.

In recognition of the diverse challenges which undermine INAM's ability to deliver it's

mandate, several past and ongoing initiatives have included activities to increase INAM's technical capacity and the spatial coverage of the hydro-meteorological monitoring infrastructure. Most notably, the Special Program on Climate Resilience (SPCR) initiative led by the former MICOA (now MITADER) with support from the World Bank and African Development Bank initiated the project "Transforming Hydro-Meteorological Services Project for Mozambique" (HYDROMET) in 2013. The objective of HYDROMET is to strengthen hydrological and meteorological information services in Mozambique to deliver reliable climate information for the country's development and local communities and to support economic development (KMC, 2015a). The HYDROMET initiative is based on three components, namely i) strengthening hydrological information management; ii) strengthening weather and climate information management; and iii) piloting resilience through the delivery of improved weather and water information. The primary emphasis of the pilot activities of this initiative has been related to forecasting and issuing warnings for floods, with minimal emphasis on the needs of agricultural users for climate and weather information. A recent review of the implementation of the PPCR in Mozambique reports that the HYDROMET initiative is increasingly focused on building technical capacity within INAM to ensure that the installed software and hardware operate effectively (CONDES, 2015).

At present a factor which limits the ability of the CGCMC to invest in significant upscaling or further development of the climate change knowledge platforms is the prevailing uncertainty over the extent of budgetary support that will be provided to sustain the operation of the CGCMC in the future. The CGCMC has been supported by funding through the PPCR initiative until the present time, however it is anticipated that the latter initiative will not be funded beyond the 2017 year and there will be a need to secure additional funds through public budget allocation or additional multilateral support. The prevailing uncertainty on the long-term financing mechanisms for the CGCMC undermines the sustainability and potential longevity of knowledge and data management systems for climate change in Mozambique, which represents a potential threat to the country's response to climate change, including within the agriculture sector.

2.7 The National Institute of Disaster Management

Mozambique's National Institute for Disaster Management (INGC, acronym in Portuguese) was created in 1999. The Institute falls under the Ministry of State Administration (MAE) and was established to coordinate actions for response to, and management of, natural disasters – most particularly floods, tropical cyclone storms and droughts. As a country which has experienced particularly negative impacts of natural disasters, INGC is mandated to coordinate disaster relief and disaster management activities with the technical and financial support of various public and private institutions, non-governmental organisations, and international organisations. Specific responsibilities of INGC include monitoring and evaluation of dynamic disaster risks, undertaking preparedness measures, coordination of disaster response, and resettlement of persons displaced by natural disasters. In those communities where INGC identifies specific risks to food security and nutrition, interventions are often undertaken in coordination with the SETSAN sub-directorate of MASA who is mandated to mobilise food aid and other interventions in response to identified Food Security/Nutrition hazards.

Within INGC, a dedicated Directorate for Arid and Semi-Arid Areas was established to identify drought-vulnerable communities, and to monitor and respond to incidents of drought and mitigate the impact of droughts on vulnerable sectors (including smallholder farmers). This Directorate is primarily focused on 29 priority districts which have been identified as being particularly vulnerable to

drought, the majority of which are concentrated in the Provinces of Gaza, Manica, Nampula, Inhambane and Tete. Support and services provided by INGC in these priority provinces includes provision of short-term drought relief to affected farmers while also including a focus on demonstration of drought-resilient and climate-smart agricultural techniques. Activities undertaken by the Arid and Semi-Arid Areas Directorate within the theme of agriculture includes distribution of inputs packages (such as drought-tolerant crop varieties), provision of extension services through trained district-level INGC workers, and promotion of low-input CA techniques (including through establishment of demonstration farm plots). INGC's CA demonstrations are established at the "Multiple Use Resource Centre" (CERUM) facilities managed by district-level municipalities (which are used to host a wide variety of public training, education and entertainment activities). The CA technologies and approaches promoted by INGC are usually based on low-input approaches such as minimum tillage with direct seeding, and establishment of planting basins, with the primary objective being to minimise the risk of crop failure due to reduced or irregular rainfall while also reducing exposure to crop failure by promoting diversification of crops and livelihoods. The suite of complementary agricultural practices promoted by INGC within the context of CA approaches may include *inter alia* adoption of drought-tolerant crop varieties and species, sustainable use of forestry products and other natural resources, diversification of livelihoods and identification of alternative/additional sources of incomes. In addition, INGC staff also promote improved management of cattle and prevention of livestock diseases, particularly in the Southern part of the country where the majority of farmers are at least partly reliant on livestock husbandry.

Despite the growing experience and expertise of INGC in promotion of CA techniques, particularly in the context of drought-prone and arid areas, there appears to be a relative lack of evidence on the effectiveness of practices promoted to drought-vulnerable farmers through INGC and the Multiple Use Resource Centre facilities. Furthermore, although INGC's activities in these thematic areas are well-established and have benefited from several years of experience, no training manuals or guidebooks on CA have been published in hard copy or appear to be available online. As a result of INGC's interest in agriculture and food security as a component of DRR and DRM, there is some apparent overlap in institutional mandate and activities between INGC and MASA. However, INGC is not formally included or acknowledged as an implementing party in Mozambique's institutional framework for agriculture and as a result is not active in the structures for coordination and communication of public agencies involved in agriculture. A consequence of the lack of coordination between the parallel activities of INGC and other stakeholders is the limited sharing of information, resources and best practices except through informal channels.

2.8 The Knowledge Management Centre for Climate Change

The Knowledge Management Centre for Climate Change (CGCMC, acronym in Portuguese) is hosted by Mozambique's Academy of Sciences within the Ministry of Science & Technology, Higher and Vocational Education (MTCESTP). The CGCMC was established under Pillar 1 of the activities initiated by the SPCR project, in line with the latter's initiative's objectives of increasing the capacity for M&E and knowledge management of climate change-related themes. The CGCMC maintains a close cooperation with MITADER's Climate Change Department. The four core activities of CGCMC are: i) raising awareness of climate change; ii) sharing information and data on climate change; iii) training on disaster management and climate change adaptation; and iv) promoting scientific research on climate change. Agriculture is one of the ten thematic areas of climate change that is included in the CGCMC's focus.

2.9 Summary Analysis: Strengths, Weaknesses, Opportunities and Threats

The institutional and policy review informed the development of a SWOT analysis (an assessment of "Strengths", "Weaknesses", "Opportunities" and "Threats"), presented in Boxes 1–4, below. Summarised recommendations and priority needs for the institutional framework that supports Mozambique's response to climate change, with particular emphasis on the agriculture sector, are provided further below in Box 5 as a conclusion to this review and Part I of the Technical Report.

Box 1:
Strengths of Existing Institutional Arrangements and Legal Framework

- The country's legal framework is aligned with national ambitions and international commitments to reduce vulnerability to climate change (CC) and support low-carbon development initiatives in sectoral and cross-cutting focal areas, as well as multiple sector-specific policies and strategies.
- Public institutions and partners at national, provincial and district levels are strengthened and increasingly harmonised through ongoing investments and technical assistance.
- There exists a national network of research and technical institutions with agricultural specialisations (e.g. technical institutes and specialised research organisations) in areas including Maputo, Gaza, Chokwe, Manica, Sofala and Zambezi.
- The sustainability and development of the agriculture sector is accorded high importance in Mozambique's plans for socio¬economic development, reflecting the importance of the sector as a source of employment and food security for the majority of the country's rural population.
- MASA's PRONEA programme is aligned with the existing strategic framework for the agriculture sector, including the Green Revolution Strategy (GRS), Agricultural Programme for Food Production (PAPA), and the Agricultural Sector Development Strategy (PEDSA, 2011–2020).
- DNEA's mandated responsibility is to "coordinate the implementation and dissemination of good practices adapted to climate change that contribute to the sustainable use of natural resources", which includes a strong emphasis on climate smart agricultural practices such as CA.
- MASA's "Action Plan for Climate Smart Agriculture" is an important enabling step to implement climate-resilient activities for smallholder farmers.
- Strategic Plan for Development of Agrarian Sector (PEDSA) is the main document which guides the development of Mozambique's agriculture sector, includes consideration of the cross-cutting challenges and threats to the agriculture sector, including issues such as gender equality, the impact of HIV/AIDS on rural communities, and the impacts of climate change and environmental degradation.
- The platform provided by the Inter-Institutional Group for Climate Change (GIIMC) is a critical body for coordination and oversight of all climate change related stakeholders and initiatives in Mozambique e.g. to ensure the relevance and alignment of proposed initiatives, to promote collaboration and prevent duplication of efforts between stakeholders and initiatives with complementary activities.
- The cross cutting priorities listed in national climate change strategy (ENAMMC) are aligned with emerging priority actions in sectoral strategies and policies such as MASA's sectoral priorities for agriculture.
- The Disaster Management Law empowers local stakeholders as primary actors to deliver an appropriate national disaster risk reduction response, including the establishment of local Disaster Risk Management Committees led by trained community members in participation with the INGC in a three-tiered early warning system that coordinates disaster response actions between national government, local government and households.
- The Land Law provides adequate security of tenure for the occupying farmer to invest in practices such as CA which may take several years to yield returns.

Box 2:
Weaknesses of existing Institutional Arrangements and Legal Framework

- Certain policy measures have mainly benefited large scale commercial agriculture (e.g. through development of irrigation facilities, promotion of commercial outgrower schemes and identification of high-value export crops) disproportionately more than smallholder farming sector.
- Coordination and monitoring of actions on climate change is challenged by ongoing restructuring and realignment of key ministries, departments and directorates.
- There is a lack of updated (current 2017) summaries and descriptions of the country's institutional framework to inform emerging research and funding proposals for climate change focused initiatives.
- "Research and systematic observation" of climate change remains ineffective as a result of the limited availability of data measurements taken at "appropriate frequency and scale".
- There is a relative lack of evidence on the effectiveness of practices promoted to drought-vulnerable farmers through INGC and the Multiple Use Resource Centre (CERUM) facilities.
- Policies and local-level strategies do not adequately consider the role of animal draught power as a potential contributor to crop production (e.g. in land preparation).
- As a result of the limited and spatially-variable coverage of INAM's network of meteorological stations across Mozambique's heterogeneous landscape, daily and seasonal climate forecasts do not provide adequate coverage and reliability at the local scale.
- Some overlaps exist in institutional mandate and activities between national level stakeholders such as INGC and MASA (for example, with respect to promotion of CA practices in Arid and Semi-Arid Zones).
- Institutional framework for coordination and communication of public agencies involved in promotion of CA and CSA approaches does not include formal mechanisms for coordination and information sharing with activities of related stakeholders such as INGC.
- The existing mechanisms for institutional coordination for sharing of data and knowledge remain weak and informal, and as a result newly generated knowledge is not necessarily being shared or publicised.
- The mechanisms for monitoring and reporting on progress achieved towards implementation of PES and PLAs are underdeveloped at the district and provincial levels.

Box 3:
Opportunities created by existing Institutional Arrangements and Legal Framework

- The National Adaptation and Mitigation Climate Change Strategy (ENAMMC) establishes clear actions and priorities across multiple government sectors.
- National Climate Change Monitoring and Evaluation Framework (SNMAMC) enables systematic monitoring and evaluation of national response to climatSe change, by reporting on progress towards implementation of ENAMMC.
- International commitments on climate change are well aligned with domestic policies and priority programmes, e.g.:
    - The SNMAMC provides a clear short (2015 to 2019), medium (2020 to 2024) and long (2025 to 2030) term framework for monitoring national activities related to climate resilience and risk reduction in the proposed NAP.
    - INDC commitments towards GHG reduction are aligned with sectoral policies and priority programmes (including sectors such as urban transport, waste management, energy, REDD+ and agriculture).
- The strategic priorities of ENAMMC include a strong emphasis on the sectors of land use change, forestry and agriculture under the pillars of adaptation as well as mitigation.

- Promotion of Conservation Agriculture is prioritised at the highest strategic level through the inclusion of "Number of households engaged in CA" as a core result indicator of ENAMMC.
- ENAMMC aims to integrate adaptation planning into local-level activities and land use through development of Local Adaptation Plans (PLAs) (particularly by replicating and upscaling PLA process in Central and Northern districts).
    - PLAs provide an opportunity to integrate principles such as CA and other forms of CSA into local-level land planning.
- The "Action Plan for Climate mart Agriculture" aims to upscale the well established Farmer Field School approach for demonstration of CA approaches.
- FFS approaches may potentially be complemented by the use of "Multiple Use Resource Centre" (CERUM) facilities for training and demonstration of climate smart agricultural techniques (as piloted by INGC in Arid and Semi-Arid Zones).
- Multiple opportunities exist to enable the development of PLAs with the support and assistance of multilateral and donor organisations as well as the private sector.
- Under the policy reforms implemented within the agriculture sector, MASA has developed the Ministry of Agriculture Food Security Diploma which approves the introduction of a performance based career development program to reward excellence in agricultural extension for climate resilient agriculture.

Box 4:
Threats posed by existing Institutional Arrangements and Legal Framework

- Smallholder farmers may continue to be excluded from investments and policy measures to commercialise and develop various agro-commodity chains.
- Environmental challenges such as soil erosion, reduced soil fertility and soil salinization will undermine the delivery of GoM's objectives for agriculture, rural development and climate change adaptation.
- "Action Plan for Climate Smart Agriculture" will be ineffective without additional investments in inter alia M&E and knowledge sharing, knowledge generation, availability and capacity of extension services, community capacity development, security of land tenure and sustainable natural resource management.
- Synergies between promotion of livestock husbandry and upscaling of the Conservation Agriculture approach using animal draught power are not adequately considered in policy.
- As a result of ongoing institutional realignments, the important intended role of the GIIMC as a coordinating body between multiple stakeholders is currently not clarified or elaborated formally.
- Limited inter-sectoral engagement, lack of standardization, irregularity and low quality of climate data are barriers to research and observation of climate change impacts.
- Challenges to accuracy and timeous delivery of agricultural forecasts and similar products may undermine general public faith and trust in meteorological services and other forms of public information and extension.
- The prevailing uncertainty on the long-term financing mechanisms for the Knowledge Management Centre (CGCMC) undermines the sustainability and potential longevity of knowledge and data management systems for climate change in Mozambique.
- There is a persistent lack of direct funding from government in annual budget for development and implementation of PLAs, which is mainly attributed to inadequate consideration/inclusion of PLAs during the development of PES and PDD budgets.
- The economic recession which currently affects Mozambique has resulted in severe impacts on government budget allocations, thereby limiting the funding available to implement PLAs and PDDs.

Box 5:
Needs and Recommendations to strengthen Institutional Arrangements and Legal Framework on climate change

- As proposed in the ENAMMC pillar on cross-cutting issues, existing institutional framework requires statutory revisions to formalise the mandate of GIIMC and the functioning of the national Climate Change Network.
- Strategies and policy instruments that guide the agriculture sector require revisions to recognise the synergies between promotion of livestock husbandry and upscaling of the Conservation Agriculture approach using animal draught power.
- There is a need to secure additional funds through public budget allocation or additional multilateral support to sustain the operation and upscaling of the Knowledge Management Centre (CGCMC).
- Operational and budgetary support is needed to enable the increased participation of FNDS in publicly-financed initiatives on climate change, sustainable resource use and other related themes.
- The 'Action Plan for Adaptation to Climate Change' proposes the inclusion of a dedicated DNEA extension unit for climate change adaptation.
- The 'Action Plan for Climate Smart Agriculture requires additional support to be sustainable and effective, including inter alia:
    - improved management and sharing of knowledge;
    - local-level identification of climate risks to agricultural value chains;
    - empowerment of communities for sustainable management of natural resources;
    - increased security of land tenure; and
    - improved availability and accessibility of inputs and technologies for smallholders.
- Local Adaptation Plan (PLA) process provides an opportunity to integrate principles such as CA and other forms of CSA into local-level land planning.
    - Implementation/development of PLAs requires adequate budget allocations within the District Development Plan (PDD). To ensure that costs of local-level adaptation are budgeted within the PDD, the process for development of Economic and Social Investment Plan (PES) should include consideration of adaptation actions for the agriculture sector, including promotion of CA approaches.
- Ongoing knowledge management and M&E needs described in SNMAMC – particularly research and development to support the productivity and efficiency of Mozambique's agriculture sector and promotion of CA – can be supported by agencies such as Agricultural Research Institute of Mozambique (IIAM).
- Prioritise and promote improved linkages and coordination between researchers and smallholder farmers, and increased participation of smallholder farmers in research and evaluation of CA approaches.
- Institutional framework for coordination and communication of public agencies involved in agriculture does not include formal mechanisms for coordination and information sharing with activities of related stakeholders such as INGC.
    - Some overlaps exist in institutional mandate and duplication of activities between national level stakeholders such as INGC and MASA.
    - Lessons learned on extension and demonstration of CA by INGC can be used to inform MASA activities (e.g. use of Multiple Use Resource Centre (CERUM) facilities for demonstration and training activities).

PART II

Review of Conservation Agriculture in Mozambique

What is the current state of knowledge, and what are the major knowledge gaps, relating to best practices for promoting Conservation Agriculture to smallholder farmers in Mozambique?

The Republic of Mozambique is considered to be particularly vulnerable to the predicted impacts of climate change, as a result of the severity of predicted climate changes in the country as well as the limited ability of the country's vulnerable sectors such as agriculture to respond to climate change. The agriculture sector is the primary livelihood basis for ~80% of the population and which contributes ~31.5% to Mozambique's Gross Domestic Product (Mazvimavi, 2011) and as a result the country is particularly vulnerable to negative impacts on this sector. As described in Mozambique's Intended Nationally Determined Contribution (INDC, 2016), the country's impoverished rural population (the majority of whom are reliant on subsistence agriculture) are vulnerable to the impacts of climate-related hazards such as drought and floods, soil erosion and saltwater intrusion, all of which impact negatively on the productivity of the agriculture sector (INDC, 2016:5). In response to the observed and predicted impacts of climate change on the agriculture sector, one of the strategic actions that will be prioritised by the Government of Mozambique (GoM) is to "Increase the resilience of agriculture, livestock and fisheries, guaranteeing the adequate levels of food security and nutrition" as part of the National Adaptation Plan (INDC, 2016). Further, the country's National Climate Change Adaptation and Mitigation Strategy (ENAMMC) includes 'Agriculture, fisheries, food security and nutrition' as one of eight areas for strategic action, noting that "conservation of agricultural land, as well as the promotion of resilient crops, is crucial" for the country to adapt to climate change.

In response to the observed and predicted impacts of climate change on agriculture, an emerging trend in global agricultural practices in countries such as Mozambique is an increasing interest in the concept of climate-smart agriculture (CSA), including practices such as Conservation Agriculture (CA). Climate-smart agriculture is an approach that aims to increase the resilience of agricultural practices and food security to climate change through adoption of a range of sustainable land management practices focused on increasing agricultural productivity, stability and climate change mitigation effects. The CSA approach is based on three main principles: i) sustainably increasing agricultural productivity and incomes; ii) adapting and building resilience to climate change; and iii) reducing and/or removing greenhouse gases emissions relative to conventional practices (FAO, 2013).

In Mozambique, an important component of GoM's strategy for the agriculture sector to adapt to climate change is the promotion of CA. Conservation Agriculture can be defined as 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, 2013a). In general, these practices are promoted in order to reduce erosion, improve soil quality and improve soil fertility and water infiltration. The Food and Agriculture Organization (FAO) defines three broad principles of CA:

- minimum or reduced soil disturbance;
- maintaining a permanent soil residue or vegetative cover; and
- crop rotations or intercropping with legumes (FAO, 2002).

Conservation Agriculture is often promoted as a farming method that promotes yield stability and food security. This is especially true in changing the production system from tillage intensive to direct seeding and residue retention (Grabowski and Mouzinho, 2013a). Globally, there is a growing body of research on CA and the practice is increasingly promoted in southern Africa and elsewhere –

however, low rates of adoption of CA practices have led to a polarized debate on the suitability of the practice to smallholder farmers in the region (Giller at al., 2009). In poor and developing southern African countries such as Mozambique, there is increasing interest in the promotion of CA as part of the national strategy to develop the agriculture sector and increase the resilience of vulnerable populations to climate change. The Government of Mozambique recognises that the development of the agriculture sector will play a key role in the country's objectives for socio-economic development and poverty alleviation, particularly in rural areas where small-scale subsistence agriculture remains the dominant livelihood and source of employment. An indication of the strategic importance of CA to Mozambique's climate change response is the inclusion of "Number of Households engaged in conservation agriculture" as a core result indicator in the National Climate Change Monitoring and Evaluation System (SNMAMC).

The promotion of CA in Mozambique has been ongoing since 1996. The primary objective of the early programmes promoting CA was to increase smallholder productivity, reduce erosion, increase soil fertility and improve the drought tolerance of rainfed agriculture (Grabowski et al., 2013c). Despite the sustained promotion of CA for over two decades, there still remains a relatively low level of adoption and acceptance of CA at a national level (Grabowski and Mouzinho, 2013a). However, at present there are no reliable means to accurately quantify the rate of adoption of CA or provide an aggregate picture of CA use at the national level (Grabowski et al, 2013a). The limited use of improved inputs is one of the most important factors that hinder agricultural productivity in Mozambique (Mouzinho et al., 2015), and as a result Mozambique's agricultural productivity lags behind most of its neighbours that have climatic and socio-economic similarities (Uaiene et al., 2013). The World Bank (2012) estimated that cereal yields in 2011/12 were estimated at an average of 700 kg/ha, which were three and four times lower than the average cereal yields in Malawi (2.1 ton/ha) and Zambia (2.7 tons/ha), respectively.

The reduction of poverty in Mozambique (particularly its rural population) will be heavily dependent on identifying strategies to increase agricultural productivity and transform the rural economy, and it is anticipated that the promotion of CA and development of priority agricultural value chains will be an important component of GoM's strategy for the agriculture sector. However, despite many years of CA research and promotion in Mozambique, there are still major knowledge gaps about how CA principles can be successfully applied to improve smallholder agriculture across Mozambique.

There is a need for increased research on multiple aspects of the CA approach, including biophysical research (such as the influence of CA on yield, soil quality and input use efficiency) as well as socio-economic research (such as the effectiveness of promotion methods, profitability, labour changes, gender impact analysis, adoption studies, and livelihood impacts) (Grabowski and Mouzinho, 2013a). An integrative approach of the above methods for introducing CA practices taking agronomic and economic analyses into consideration may contribute with new results to increase the underlying adoption. There is a general need to develop tailored CA technologies that are adapted to the diverse agro-ecological and socio-economic conditions across Mozambique to support the wide-scale adoption of the CA approach. This chapter of the technical report explores the current state of knowledge, and the major knowledge gaps, relating to the best practices for promoting CA to smallholder farmers.

3 Promotion of CA to rural smallholder farmers

In recognition of the benefits of CA to Mozambique's smallholder farmers, the practice has been promoted in various forms for over 20 years. Grabowski and Mouzinho (2012) reported an estimate of at least 27 development organizations, 10 research organizations and five private sector organizations that have been actively participating in conservation agriculture initiatives across at least 80 of the country's 128 districts. The purpose of the majority of these CA initiatives has been to increase smallholder productivity, reduce erosion, increase soil fertility and improve the drought tolerance of rainfed agriculture (Grabowski et al, 2013a). To understand how CA can be effectively promoted in Mozambique, it is imperative to look at how it has been promoted in the past and what initiatives were undertaken. This chapter provides policies and examples of past projects and initiatives which have focused on promotion of CA in Mozambique and elsewhere in Africa.

3.1 Promotion of CA in East and Southern African countries

Conservation agriculture is a set of principles incorporated in a diverse range of technologies from mechanized to hand-hoe land preparation. Grabowksi (2011) distinguishes between two extremes of CA with one being the traditional slash and burn agriculture (common in tropics where natural vegetation is cleared). On the other extreme is mechanized agriculture that has led to adaptations in equipment for injection of seeds into undisturbed soils (common in North and South America and Australia). Maize is the staple food in most of the southern Africa region and is therefore the focus of many CA projects. However, CA can be used on many other crops (cotton, sorghum and millet are grown with CA in the region). Conventional agriculture in Mozambique contributes to land degradation through erosion and nutrient mining. This is caused by the intensive cultivation of the soil without fertilizer application (Famba, 2010). The use of CA practices and technological changes in agricultural practices can prevent land degradation by reducing erosion and nutrient mining Grabowski, 2011).

In order to overcome the negative effects of tillage-induced degradation, there have been numerous efforts to develop CA in various East and Southern African (E&S Africa) countries. These efforts are led by multiple institutions including public, commercial, religious, research and development organizations (Wall et al., 2013). E&S Africa is characterised by widespread land degradation which has resulted in a general long-term decline of ecosystem function when measured in terms of net primary productivity (Bai et al., 2008). This trend of land degradation and declining ecosystem productivity is closely linked to rural household food insecurity and poverty (Malley et al., 2006). As is prevalent in most African countries, most of the cropped area of E&S Africa are based on systems of mixed maize production or an agro-pastoral livestock production combined with millet/sorghum cropping (Dixon et al., 2001). As a result, there are a number of diverse examples of promotion of CA linked to maize-based systems.

One of the earliest examples of the promotion of zero tillage practices in E&S Africa was in the highlands of Kenya in the mid-1970s, which was initiated in an effort to conserve rainwater and reduce the costs of crop production (Wall et al., 2013). In South Africa, the practice was first implemented in 1976 when the Agricultural Research Council of South Africa started with trials conducted over the maize-growing areas of South Africa (Berry et al., 2001). Farmer-managed

demonstrations were also started by the Ministry of Agriculture of Rhodesia (now Zimbabwe), with little success (Oldrieve, undated). It was only in 1982/83 season season that Oldrieve began experiments with CA by developing systems and conducted outreach programmes for smallholder farmers in the country (Oldrieve, 1993).

As a result of the increased promotion of CA and various related agricultural principles in a growing number of African countries, there is a wide variety of best practice examples and case studies to inform future efforts to promote and increase the adoption of CA by climate-vulnerable farmers in Mozambique. However, there is also a need to investigate the specific experiences of Mozambique's farmers in the promotion and adoption of CA. The need to adapt CA to the local context of smallholder farmers has been well established in the literature (see for example: Giller et al., 2009; Wall, 2007), which can be facilitated through research methodologies that include extension participation and collaboration of farmers (Grabowski et al., 2015a). The increased interest of GoM in CA as a tool for economic development and strengthening of the rural agricultural sector is reflected in a number of policy measures and projects implemented over the period 1996–2016. Some examples of the initiatives and strategies which made significant contributions to the knowledge base on CA in Mozambique are summarised below.

3.2 Promotion of CA: CA policies developed by the Government of Mozambique

The promotion of conservation agriculture as a component of Mozambique's agricultural and socio-economic development has been the result of several successive policy measures since the 1990's. After the country's independence, then-President Chissano initiated the development of Agenda 2025 in 1988 - a participatory process involving all citizens to reflect on the future of Mozambique. This initiative was published by the Republic of Mozambique in 2003. One of the undertakings in this document include the development of initiatives to increases access to essential services (such as infrastructure, education, credit) to increase the productivity and sustainability of Mozambique's agriculture sector. Some examples of the initiatives and strategies which made significant contributions to the knowledge base on CA in Mozambique are summarised below.

The Agricultural Policy and Implementation Strategy (PAEI, acronym in Portuguese) was formulated in 1995 with the stated objective to address food insecurity and poverty while promoting sustainable economic growth through providing increased support to smallholder farmers (among others) (Cammaer, 2016). However, some observers have noted that the PAEI did not result in major transformation of the rural subsistence economy and primarily contributed to the development of the commercial farming sector (CARE and ActionAid, 2015). As a result of the need to encourage foreign direct investment into the development of Mozambique's considerable agricultural potential, the promotion of agribusiness development and provision of extension services was mainly focused on commercial/cash crops such as cotton, tobacco, tea, sesame and sugar, and with relatively little emphasis on development of smallholder subsistence agriculture (Cammaer, 2016).

The country's policy framework developed further towards the promotion of conservation agriculture through the formulation of the **Priorities for Development of the Agricultural Sector** (*Prioridades de Desenvolvimento do sector Agrícola,* **2006–2009)** by the Ministry of Agriculture and Food Security in 2006. The focus of this document was to prioritise interventions and resources for those activities that have the potential to support poverty reduction, promote diversification of food security, build resilience to climate and market fluctuations, and promote the adoption of improved technologies (Cammaer, 2016). As a result, the priority actions identified resulted in an increased promotion of agricultural inputs and

techniques for sustainable land management and soil conservation and the explicit promotion of climate-resilient practices.

In 2007, the **Alliance for a Green Revolution in Africa (AGRA)** initiative encouraged African nations to advance a green revolution in the continent (Cammaer, 2016). The AGRA initiative aimed to promote policies that support small-scale farmers, rural development, environmental sustainability, and marketing that is favourable to poor farmers (AGRA, 2015). The GoM proceeded to establish its own Green Revolution Strategy in 2007 focusing on the family farming sector, the promotion of farmer's associations, the development of markets for improved agricultural inputs and agricultural commodities, and the conservation and sustainable use of natural resources (MINAG, 2007).

The global food price crisis of 2007 triggered a change from market-oriented cash and food crops to the production of food crops such as wheat, rice, cassava, potatoes and oilseeds for national consumption and to reduce dependence on imports. This social instability in Mozambique and elsewhere in the region in early 2008, resulted in a sharp rise in fuel prices and this resulted in the establishment of the **Action Plan for Food Production** *(PAPA, acronym in Portuguese)* (Cammaer, 2016) in June 2008. The PAPA was established to address the challenge of rising global food prices by reducing the deficit of staple food production from 2008 to 2011 as well as reducing dependence on imports. It was established by an inter-ministerial team convened by the GoM to advise on key areas of action. The PAPA's dual objective of eliminating the deficit of the most common food products as well as to reduce the national dependency on food imports (Mangwiro, 2008). The Action Plan for Food Production is mostly to assist the rural masses of Mozambique. For most rural people in Mozambique, access to staple foods is largely from home production and this links to access and ownership of land. Another factor for the development of the PAPA is closely related to poverty and lack of income opportunities. The significant decline in remittance income in recent years has contributed to lack of economic opportunities, particularly for households in parts of the South as there is a marked North-South divide with food production concentrated in the North (FFSSA, 2004).

The implementation of PAPA highlighted gaps in the National Sub-System for Agricultural Development Planning and respective Framework, which led to the formulation of the **Strategic Plan for Development of Agriculture Sector (PEDSA, 2011–2020).** The **PEDSA** (2010–2019) was approved in May 2011 and is currently the main guiding document for the development of the agricultural sector. The objective of the PEDSA was to guide the efforts of development partners and align agricultural development with national, regional and international frameworks and priority actions (RoM, 2010), and to transform the agricultural sector from predominantly subsistence agriculture to a more competitive and modernized agriculture sector which ensures self-sufficiency as well as socio-economic development. The PEDSA mentions the dependence of the agriculture sector on fertiliser imports and encourages in-country production and provision of the necessary inputs for agricultural production, as well as the need to introduce significant improvements in the sustainable use of land, water and forests. Through PEDSA, the GoM aims to: i) increase the availability of food through growth in smallholder producer productivity and emergency response capacity; ii) enlarge the area of land under sustainable management and the number of reliable water management systems; iii) increase access to the market through improved infrastructure and interventions in marketing; and iv) improve research and extension for increased adoption of appropriate technologies by producers and agro-processers (Suit et al., 2015). The PEDSA is operationalized through implementation of five-year and annual plans (starting in 2010–2014), of which the PAPA (2008–2011) formed part of the first five years. In order to achieve the objectives

of PAPA, the government increased the use of inorganic fertilizers and improved maize seeds by distributing vouchers in the high potential provinces covered by the Survey on Price Dynamics of 2011 (Mouzinho et al., 2015).

The **National Investment Plan for the Agricultural Sector, 2014–2018 (PNISA)** plan was developed in 2013 to operationalize the PEDSA, while at the same time implementing the Comprehensive Africa Agriculture Development Programme (CAADP). The PNISA's intended outcomes include: i) accelerate the production of staple and nutritious food products; ii) guarantee income for producers; iii) ensure access and secure tenure of the necessary natural resources; iv) provide specialized services geared towards the development of the value chain; and v) boost the development of the areas of greatest agricultural and commercial potential. In support of the above objectives the plan has formulated 21 programmes and 65 sub-programmes under five Strategic Objectives, of which the most important and relevant to the promotion of CA is "Strategic Objective 3: Land, water, forest and wildlife resources used sustainably".

3.3 Promotion of CA: examples of past CA projects in Mozambique

In the working paper *Climate Learning for African Agriculture: The Case of Mozambique*, Parkinson (2013) provides case studies of three climate change adaptation projects focused on promotion of CA. The research was undertaken as a collaborative initiative between the African Forum for Agricultural Advisory Services (AFAAS), Forum for Agricultural Research in Africa (FARA) and the University of Greenwich's Natural Research Institute.

3.3.1 Project on Coping with Drought and Climate Change in the Guija District

In 1999, the GoM approached the United Nations Development Program (UNDP) to pursue the development of a UNDP-supported project focused on adaptation to climate-related challenges identified by farmers surveyed in the Lower Limpopo, the semi-arid interior of Gaza and Inhambane provinces, and the Upper Limpopo zone. It was intended to contribute to the government's goal of enhancing food security and the capacity to adapt to climate change in agriculture. The combination of vulnerability to climate change and the need to create synergies with ongoing drought management activities led to the prioritisation of two communities in the district of Guija district. The project was implemented with the leadership of MICOA (now MITADER) from 2009–2012 with the stated objective "to develop and pilot a range of coping mechanisms for reducing the vulnerability of farmers and pastoralists to future climate shocks". The project worked to improve the livelihood strategies and resilience of farmers to drought through safeguarding water supply, introduction of enhanced farming practices and improvement of community-based natural resource management. The project also piloted the establishment of early warning systems to bolster resilience in the agricultural sector to drought (Parkinson, 2013).

3.3.2 Environmental Mainstreaming and Adaptation to Climate Change in the Chicualacuala District

The UN Joint Programme project "Environmental Mainstreaming and Adaptation to Climate Change" was implemented in 10 villages in the district of Chicualacuala in Gaza Province from 2008–2012, involving the participation of ~1,000 direct beneficiaries in collaboration with UN agencies and several GoM departments and ministries (see,

Parkinson, 2013). The UN Joint programme was designed to align with government policies, plans and strategies, notably the National Adaptation Programme of Action (NAPA) and PARPA (Plan for the Reduction of Absolute Poverty), to create synergies and avoid duplication. The conception of the programme aimed to integrate considerations of climate change into national policies, while aiming at the local level to support farmers in adapting to the effects of climate change. The implementation of the project was led by MICOA in coordination with other participating government entities (Parkinson, 2013).

The Chicualacuala project also implemented conservation agriculture as a means of adapting to climate change in six communities using three techniques, namely: i) minimum tillage; ii) maintenance of soil surface cover; and iii) intercropping. This project showed that CA is likely to be more widely accepted if the basic principles are broadened to include crop-livestock interactions that encourage multipurpose trees and grass species that can be used for both human and livestock needs. An important lesson emphasised by the project is the need for beneficiaries to be actively involved in all stages of the project, from design to completion of activities, as this ensures a sense of ownership of the project's activities by beneficiaries and is necessary to ensure the continuation of the project's outcomes beyond the implementation period.

3.3.3 CARE Climate Change Project in the District of Angoche

The CARE Climate Change Project in the district of Angoche was established in 2012. This adaptation initiative was conceived as a continuation of CARE's past work in Angoche District through the ACCRA initiative which was implemented in partnership with the Nampula Association of Extensionists (AENA, a local NGO). The primary focus of the CARE CCP was to promote adaptation in the agriculture sector to improve and safeguard the resilience of livelihoods in coastal and inland communities against immediate climate-related risks. The CCP has collaborated with IIAM on seed improvement and with the Eduardo Mondlane University (UEM, acronym in Portuguese) on communication of extension advice. The activities of the CCP are primarily based on promotion of climate-smart agricultural practices focused on reducing the impacts of irregular or reduced rainfall on crop production, such as conservation of soil organic matter, maintenance of tree cover adjacent and within fields, and adoption of improved drought-tolerant crop varieties (Parkinson, 2013).

Some of the lessons generated by the CCP to be considered by future research and projects focused on promotion of CA in the district include *inter alia*:

- tailoring of recommended approaches to CA to respond to specific local contexts and local climate risks;
- integration of sustainable agricultural approaches into the smallholder agriculture sector to reduce pressure on natural resources;
- training of farmers and community members in activities and livelihoods based on sustainable natural resource use, which can potentially play a central role in successful local interventions; and
- the need for a more widely accepted definition of CA, with the inclusion of crop-livestock interactions and promotion of multipurpose tree and grass species for both human and livestock needs.

3.3.3.i Farmer Field Schools

The establishment of Farmer Field Schools (FFS) is an approach that was developed through the Farming Systems Research (FSR) movement of the 1970s which was characterized by on-farm participatory trials. The FSR emphasized interdisciplinary research to address the complex interactions of the farming system (Bingen and Gibbon, 2012). The approach was originally known

as the 'Farmer First' movement and developed innovative methodologies such as the Participatory Rural Appraisal approach that encouraged researchers to collaborate with farmers and which generated information that contributed to empowerment of farmers (Chambers et al., 1989). The FFS is a methodology that uses adult education principles and can be considered as an approach to facilitating behavioural change in context-specific farming practices (Braun et al., 2006).

In general, the FFS approach involves the participation of a small group (20 to 30) of farmers in regular meetings in the field with the participation of an outside facilitator to propose and compare potentially appropriate agricultural practices (Waddington et al., 2012). For FFSs to effectively contribute to participatory research on CA technologies, they must be implemented in a bottom-up approach that will encourage the meaningful participation of farmers in decision-making (Grabowski et al., 2015b). CARE implemented the Adaptation Learning Programme (ALP) project in Mozambique, which included the establishment of eight FFS learning groups with the direct participation of at least 200 farmers. Several of the CARE FFS initiatives are summarised below.

3.3.3.ii Capacity development for local civil society and government institutions in the Nampula Region

CARE and the National Association of Rural Extension (AENA, acronym in Portuguese) used the FFS approach to strengthen links between different service providers and build the capacity of farmers to practice sustainable agricultural techniques in the Angoche District of Nampula Region. The project involved weekly demonstration meetings throughout the year, with an emphasis on protecting and building soil fertility and introducing a wider diversity of crop varieties, as well as promoting the concept of climate-resilient livelihood strategies for farmers. This collaborative FFS initiative between farmers and extension workers (facilitators) encouraged regular discussions with the farmer to analyse their own techniques and knowledge, assess the value of new practices introduced by the facilitators and to independently conduct their own experiments in farming innovation. As a result, the initiative provided an effective platform for learning that allowed farmers to directly relate the practices on demonstration to their existing livelihoods and practices.

The project also included a focus on how farmers might better access weather information via text messages from local disaster risk reduction agents or by radio. This innovation has the potential to alleviate climate risks by providing farmers with early warnings of cyclones, floods and droughts as well as by providing seasonal forecasts of probability and timing of rainfall. The aforementioned kinds of climate information and knowledge will support informed decision-making on which crops to plant and when. A large part of this FFS project involved social mobilisation that aims to address the underlying causes of vulnerability and this contributed directly to building the adaptive capacity of participating farming communities (CARE, 2014.).

3.3.3.iii Learning how to farm again in rural Mozambique: CARE case study for use around IPCC WG II Report

CARE's initiatives in Mozambique also included a FFS initiative in the village of Sinhanhe, Angoche District in Nampula Province. This initiative aimed to address the negative impacts of reduced rainfall in the district, which included reduced agricultural production, reduced availability of water for irrigation and drinking water for households and livestock. The FFS initiative aimed to address these negatives impacts in Sinhanhe by assisting farmers to identify and learn new techniques to adapt to an increasingly unpredictable climate. After a year of implementation, the local community began to note the beneficial impacts of the techniques demonstrated, such as improved soil fertility and

increased crop productivity, despite having received erratic rainfall. Before the FFSs were started in the Nampula Region, the residents of Sinhanhe were dependent on traditional farming techniques such as deep tillage, close spacing of seeds, rotation of monoculture crops and growing a number of plant varieties in close proximity. Increasingly, participants in the aforementioned FFS are adopting techniques such as minimum tillage, use of green mulch and intercropping. Furthermore, FFS participants are increasingly making use of weather forecasts to assess the most appropriate timing and combination of crops. As a result, the community of Sinhanhe is reportedly benefiting from higher yields and a lower vulnerability to erratic rainfall (CARE, 2014).

3.3.4 Examples of recent studies on the beneficial effects of CA on crop performance and livelihoods

Despite the sustained promotion of CA, there is a relatively small body of published scientific literature on the biophysical and agronomic impacts of long-term implementation of CA techniques in Mozambique. In part, this can be attributed to the wide diversity of practices demonstrated by various initiatives which can be considered a form of 'CA'. Another factor which undermines a realistic assessment of the evidence-base for CA approaches is the relatively long time for the full benefits of soil conservation to accrue *inter alia* increased organic matter content, increased water holding capacity, and increased fertility of soils. As a result, there are a lack of studies which have identified plots and farming communities which have been managed under CA techniques for multiple successive seasons. However, the research undertaken by initiatives such as the Michigan State University Food Security Group (MSUFSG) in participation with IIAM have generated useful results which provide some means of quantifying the relative costs and benefits of CA approaches at a local level (examples described further below). The quantifiable findings of the studies listed below are further summarised in Chapter 3.4.

3.3.4.i Labour input and yield study in Angonia

Grabowski (2011) undertook a study on the impacts of labour inputs on maize yield among 18 CA farmers in a community in Angonia, Mozambique. The purpose of the study was to understand why farmers only adopted CA methods on plots where additional inputs (i.e. agrochemicals, improved seeds) have been provided by NGOs. The study found that the cost of herbicides was too high for most farmers compared to the cost of labour for manual weeding, thereby reducing the profitability of CA approaches which use herbicide as an approach to reduced tillage. Furthermore, the study found that most farmers do not have adequate funds to purchase inputs for all their crops, and generally prefer to purchase fertiliser for cash crops such as potatoes rather than subsistence crops for home consumption such as maize – this preference may be attributable to a perception of higher returns from potato production/marketing compared to a surplus of maize.

3.3.4.ii Linking Conservation Agriculture and livelihoods in villages

The research undertaken by Nkala (2012) in support of a Doctoral thesis investigated the link between CA and livelihoods in three villages in Central Mozambique, with an emphasis on characterising household-level vulnerability as well as the potential impacts of CA on livelihoods, including ~75 households who had adopted conservation agriculture techniques to varying degrees as well as ~90 households who had not adopted any conservation agriculture techniques. The results of Nkala's research are summarised within the thesis and were also prepared as manuscripts for peer-reviewed publication, the findings of which are described below.

The journal manuscript entitled "Energy and labor efficiency in smallholder conservation agriculture and conventional farming in central Mozambique" (Nkala et al., 2012a) analysed labor and energy efficiency in smallholder conservation agriculture (CA) compared to conventional farming (CF). This included an assessment of all the direct and indirect energy inputs for both agricultural techniques, as well as an estimate of the total calorific value of resultant maize yield. The study found that conventional farming (CF) expends more energy in land preparation through the use of more inputs than in CA (total energy input was estimated as 14,774 $MJ.ha^{-1}$ for CA compared to 16,153 $MJ.ha^{-1}$ for CF). The greater energy demands for CF was suggested to be a result of the more intensive requirements for land preparation under CF, particularly because "*tilling the soil requires a considerable amount of energy whether accomplished by human, animal or tractor power*". The study notes the comments of one particular farmer, who said that the CF approach consistently required greater inputs of human labor and oxen compared to CA. Therefore, the study suggested that certain approaches to CA have the potential to be more productive and less energy intensive compared to CF. The study ultimately concluded that CA provided a comparatively more efficient ratio of energy outputs (EO) to inputs (EI), compared to CF. EO/EI for CA ranged from 2.7–5.9, while EO/EI for CF was comparatively smaller at 1.1–2.2. If practiced effectively in the correct context, the apparent energy savings of CA approaches could be exploited for the benefit of livelihoods by channelling some energy into other livelihood-generating activities (if not through expansion of cultivated area and agricultural output).

Nkala's study also includes several years of data from experimental plots which recorded maize yield on CA and CF plots in the years 2006–2010. In all years, CA provided comparatively larger yields (ranging from ~2.1–4.7 $tonnes.ha^{-1}$) than CF (~0.9–1.8 $tonnes.ha^{-1}$), although yields varied between years as a result of rainfall variability in both CF and CA plots.

The findings of the aforementioned study are complemented by another journal manuscript included in Nkala's thesis, entitled "Conservation Agriculture and Livelihoods of Smallholder Farmers in Central Mozambique" (Nkala et al., 2011). The latter study investigates correlations between adoption of CA and various direct (e.g. agricultural productivity, crop yields) and indirect (e.g. household income, food security) proxies of agricultural production and livelihoods.

The study notes that the potential influence of CA in improving livelihoods of smallholder farmers is a contested topic and that the potential benefits of CA for impoverished smallholders coping with the challenges of limited agricultural productivity and extreme food insecurity is debatable. Nkala *et al.* (2011) did find evidence of the productivity-enhancing benefits of CA, where adoption of CA practices was found to be significantly associated with reported improvements in crop yields. "*Reported livelihood changes are statistically different between CA and non-CA farmers with regards to perceived improvements in productivity whereby 72% of CA farmers report improvements in productivity compared to 19% of non-CA farmers… Direct correlations between conservation agriculture, higher productivity and yields; and indirect correlations with changes in household incomes and food security are suggested.*" (Nkala *et al.*, 2011).

The authors suggest that "*it is possible to realize small positive short run benefits form CA, which may increase gradually in the long run… further supported by anecdotal evidence that shows that successful CA farmers have made significant livelihoods improvements explained by accumulation of household and farming assets and social capital further strengthening the case for conservation agriculture in the enhancement of livelihoods of smallholder farmers*".

However, despite this finding which supports the perceived benefits of CA, the authors also note that results should be interpreted with the understanding that the relative effectiveness and relevance of the approach is influenced by context-specific factors

such as local ecology and the categories of farmers in each area. For example, Nkala et al. (2011) found that those farmers who were successfully practicing CA tended to be comparatively wealthy relative to their CF-practicing neighbours. Several factors were suggested to explain the comparatively higher rate of adoption of CA among wealthier farmers, including: i) the likelihood that farmers selected for participation in the initiative which promoted CA were selected from memberships of existing Farmer Field Schools, therefore resulting in a bias towards more successful and capacitated farmers; and ii) perceived common practice that wealthier households are more likely to join new projects and interventions.

In addition, the authors noted that it was likely that wealthier households are the only ones who are able to invest in the appropriate technology and land preparation activities to be able to practice CA effectively i.e. "*wealthier households, with higher asset endowments are more likely to practice conservation agriculture than their poorly resourced counterparts*" (Nkala *et al.*, 2011). Therefore, despite the apparent potential benefits of CA to agricultural production, food security and livelihoods if practiced correctly and consistently, the authors suggest that the full potential of CA will not be realised in Mozambique in the absence of "policies that reduce poverty or increase asset holdings of households". Furthermore, the authors recommend policies which "*correctly target conservation agriculture to appropriate categories of well-resourced farmers and empowerment for the poorer groups of farmers*".

3.3.4.iii Maize-legume intercrops under no till

Rusinamhodzi et al. (2011) undertook a study of maize-legume intercrops under 'no till' management in Manica and Gorongosa, Central Mozambique. The study aimed to: i) "*evaluate the productivity of maize-grain legume intercropping as an alternative to sole cropping especially in mixed crop-livestock systems where harvest/cereal crop residues are fed to livestock and thus are not available for mulch*"; and ii) "*understand the circumstances that lead to the success of maize-legume intercropping under no-till, and to identify challenges and opportunities for improved impact*". The study assessed two approaches to intercropping, namely alternate row and within-row intercropping of maize in combination with cowpea and pigeonpea. The study reported positive land equivalent ratios and reduced risk of crop failure for both approaches (within-row and alternate row), and that the overall productivity (i.e. the summed productivity of all crops grown) of intercropped plots was consistently equal to or greater than monocropped maize. The within-row intercrops were more productive with land equivalent ratios (LER) of between 1.2 and 1.6, compared with alternate row intercrops with LER values ranging between 1.05 and 1.40.

Perhaps of greater significance in terms of food security and nutrition was the study's finding that intercropped maize/pigeonpea or maize/cowpea provided a safety net against complete crop failure, where the legume crops survived the 2009/2010 season which was characterised by a failure of maize crops as a result of a prolonged dry spell. Other findings of interest include the authors' observations that the labour requirements for weeding are increased under approaches based on intercropping and no-till management, compared to Conventional Farming (CF) approaches which rely on broadscale ploughing for land preparation. Over the course of the growing season, the total time spent on weeding was ~17.6 hours for monocropped maize compared to 22.3 and 26.4 hours for in-row and alternate row intercropping, respectively.

The study included a survey of participating farmers to assess their relative satisfaction with the various intercropped and monocropped approaches, using a subjective assessment of acceptability of the crop based on weighted questions relating to food security, cash income, input costs, ease of weeding and time to maturity. In general, farmers expressed a preference for the intercropped approaches - out

of a theoretical maximum of 100, intercropped approaches scored ~73-84% compared to ~57-61% for monocropped approaches.

Similar to the observations of Nkala (2012), Rusinamhodzi et al. (2011) reported that the majority of CA-practicing farmers were from middle income households, and virtually none from the poorest and least-resourced farmers. This finding is in line with over observations in the literature which suggests that poor farmers are particularly risk-averse and may be unable to invest in sustained adoption of CA as a result of lack of capital/funds. Another challenge noted by farmers interviewed in Rusinamhodzi et al. (2011) is the difficulty in keeping livestock out of CA plots and preventing the grazing of crop residues (which is generally acceptable in most CF approaches, which typically do not aim to conserve crop residues and which allows cattle to roam freely after harvesting annual maize crop). Farmers have responded to this challenge by focusing on intercropping and pigeonpea production on plots close/adjacent to the homestead. The study concludes that the continued involvement of farmers in the assessment and improvement of intercropping approaches is necessary to tailor CA approaches and technologies to their objectives and settings. Furthermore, the study concluded that maize-legume intercropping combined with reduced tillage reduces the risk of crop failure, improves productivity per unit area and ensures food security in vulnerable production systems.

3.3.4.iv Assessing the Influence of Conservation Agriculture on Household Wellbeing and Maize Marketing in Tete and Manica

The thesis research undertaken by McNair (2013) investigated the linkages between CA practices and proxies of livelihood improvement, such as household wellbeing and volume of maize marketed. In line with other studies described previously, McNair generally found a positive correlation between household wellbeing (measured by proxy dimensions including *inter alia* animal ownership, productive asset ownership, quality of housing construction materials, and access to water and sanitation) and the adoption of CA approaches. Further, McNair found that farmers who practiced CA tended to sell larger volumes of maize, and purchased smaller quantities of maize, compared to households that practice traditional forms of CA. (McNair et al., 2012; McNair, 2013).

The results of McNair's study support the findings of other researchers (e.g. Rusinhamdozi, Nkala) that households which practice CA tend to be wealthier or enjoy a higher standard of living than other households in their community practicing traditional agriculture. However, McNair notes "causation is difficult to establish due to the cross-sectional nature of the survey. The question remains: are CA adopters better off because they adopted CA, or are CA adopters wealthier to begin with?" (McNair, 2013). The finding that farmers who practiced CA tended to have greater livestock assets than traditional farmers was considered surprising by the authors, for the reason that the practice of allowing livestock to graze on crop residues is counterproductive to CA techniques which aim to conserve crop residue and therefore it might be expected that traditional farmers would keep relatively more livestock. The association between livestock wealth and the likelihood of practicing CA is therefore suggested to reflect the inherent tendency of wealthier households to be exposed to CA initiatives and to take risks on new approaches, rather than suggesting that CA practitioners become wealthier or accumulate livestock assets after adopting CA (McNair et al, 2015).

3.3.4.v PROMEC Initiative – Conservation Agriculture Approach for Poverty Reduction and Food Security in Sofala Province

The PROMEC initiative was funded by the Austrian and German governments in the period 2003–2006, with a focus on the promotion of CA in participation with ~1,200 farmers in Sofala province. The practices promoted by the PROMEC initiative included CA practices such as use of cover crops, mulching and crop rotation. Beneficial impacts reported by project participants in Sofala province included *inter alia*: i) yield increases of up to 30%; ii) demand for irrigation reduced by up to 60%; iii) labour requirements for weeding reduced by up to 90%; iv) labour requirements for soil preparation reduced by up to 75%. The PROMEC initiative reported immediate benefits to the application of CA principles in horticultural crops. In the case of onion, it was reported that adoption of CA approaches resulted in reduced labor for land preparation (from 45 days to 7 days), reduced need for weeding (from 14 weedings to none) and reduced irrigation (from three times to once per week) (Taimo et al. 2006).

3.3.4.vi Aga Khan Foundation – Introducing Conservation Agriculture in the Quirimbas National Park of Cabo Delgado, northem Mozambique

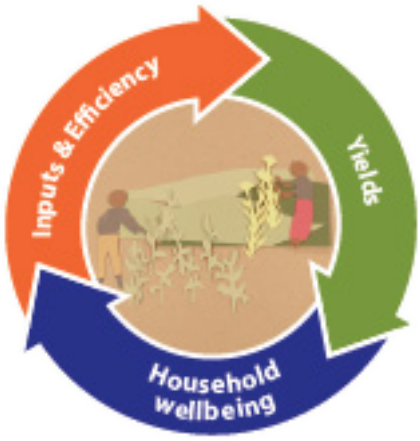
In Cabo Delgado province, the Aga Khan foundation has been promoting the introduction of CA through promotion of activities such as planting basins, use of mulch, cropping of legumes and other intercropping combinations. Dambiro et al. (2011) undertook a study to assess the effects of CA approaches on yield of maize and cowpeas among the participants in the Aga Khan initiative. Unfortunately, the latter study did not include control plots, and so as a result the study is only able to compare yields between years without accounting for possible differences in rainfall between each year. However, despite the lack of a control for comparison, Dambiro et al. found that CA approaches resulted in increased yields of both maize and cowpea every successive year of cropping, relative to baseline yields (using 'traditional' agricultural methods). The latter study reports that maize yields increased gradually from 0.8 tons/ha (baseline) to 1.2 tons/ha in 2010 and then jumping to 3.2 in 2011. Cowpea yields also increased steadily from 0.6 tons/ha to 1.7 tons/ha in 2011 (Dambiro et al. 2011).

3.4 Summarised effects of Conservation Agriculture compared to Conventional Farming approaches

The studies described in Chapter 3.3, above, provide an indication of the potential beneficial effects of CA approaches compared to Conventional Farming (CF). Consistent with the observations of other authors, the range and scale of potential beneficial effects of CA approaches is highly variable between specific crops, agro-ecological regions and methods. As a result, it should be emphasised that results observed are likely to be highly context-specific and should not be assumed to be applicable to all farming systems and regions of Mozambique.

Some highlights of these data are summarised diagrammatically in Figure 5 (overleaf, below) depicting examples of the cumulative beneficial effects of CA relative to CF approaches. The data provided in Figure 5 is described in more detail in Tables 1–3 (including references and location of study site), overleaf, which further summarise the quantifiable effects of CA approaches, relative to CF approaches, described previously in Chapter 3.3. Impacts and effects of CA are categorised as follows: i) effects on inputs, efficiency, cost-effectiveness and land equivalent ratio (Table 1); ii) effects on agronomic productivity and yields (Table 2); and iii) effects on household wellbeing and livelihoods.

Variable	CA vs. CF
Energy inputs for crop preparation (GJ/hectare)	CA: 14.8 CF: 16.2
Ratio of Energy Outputs (EO) to Inputs (EI)	CA: 2.7–5.9 CF: 1.1–2.2
Land Equivalent Ratio	CA_1: 1.2–1.6 CA_2: 1.05–1.4 CF: 1
Time spent weeding (hours)	CA_1: 22.3 CA_2: 26.4 CF: 17.6
% change irrigation demand	CA 60% < CF
% change weeding labour	CA 90% < CF
% change land preparation labour	CA 75% < CF



Variable	CA vs. CF
% Increase maize yield	CA 30% > CF
Maize yield, 2009–2011 seasons (tonnes/hectare)	CA: 1.2–3.2 CF: 0.8
Maize yield, 2006–2010 seasons (tonnes/hectare)	CA: 2.1–4.7 CF: 0.9–1.8
% of farmers that report increased productivity	CA: 72 CF: 19

Variable	CA vs. CF
Crop failure	CA_1, CA_2 survived 2009/2010 dry spell CF crops failed
% Farmers reporting satisfaction	CA: 73–84 CF: 57–61
Livelihood and wellbeing	CA farmers have higher animal ownership, productive asset ownership, quality of housing materials, and access to water and sanitation
Marketing of surplus maize	CA farmers purchase less maize, and sell more, relative to CF farmers

Figure 5 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	Results: CA vs. CF[1]	Methods	Reference
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]	CA_1: 1.2–1.6 CA_2: 1.05–1.4 CF: 1	Manica, Gorongosa (Central Region) CA_1: Within-row intercrop CA_2: Alternate-row intercrop	Rusinamhodzi et al. (2011)
Time spent weeding (hours)	CA_1: 22.3 CA_2: 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		

Table 2 Effect of CA vs CF approaches: Yields and productivity

Variable	Results: CA vs. CF	Methods	Reference
% 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 *incl* 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. (2012a)
% of farmers that report increased productivity	CA: 72 CF: 19		Nkala et al. (2011)

Table 3 Effect of CA vs CF approaches: Inputs, efficiency, cost-effectiveness and land equivalent ratio

Variable	Results: CA vs. CF	Methods	Reference
Crop failure	CA1, CA2 survived 2009/2010 dry spell CF crops failed	Manica, Gorongosa (Central). CA_1: Within-row intercrop CA_2: 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

4 Factors which influence the likelihood of sustained adoption of CA by farmers in Mozambique

As a result of the sustained promotion of agricultural development, including initiatives which have promoted CA in particular as well as rural development and agricultural productivity in general, extensive lessons learned and best practices have been generated by various by government-, NGO- and bilateral initiatives. Several researchers have noted previously that, despite the sustained promotion of the CA approach at the level of agricultural policy and local-level extension services, the majority of the country's rural smallholder farmers have not yet fully adopted the CA approach. The challenge of transferring new technologies, approaches or crops to smallholder farmers is not unique to Mozambique, where structural challenges such as limited access to inputs, credit, public education and extension services are common across Southern Africa. However, although the lessons learned by neighbouring countries are valuable to Mozambique's efforts to promote CA and increase the climate-resilience of vulnerable smallholder farmers, there is also an urgent need to review and learn from past and ongoing initiatives informed by the specific experiences of Mozambican initiatives.

The factors which influence the likelihood that a farmer or farming community will adopt and sustain some form of CA practice are complex and inter-dependent, and are also likely to vary between and within various social, economic and environmental/agro-ecological contexts. In addition, there is a need to distinguish between the categories of decisions/choices that influence the adoption of alternative agricultural practices such as CA – for example, the need to distinguish between a farmer's willingness, technical capacity and economic means to practice CA. As described briefly in Chapter 1, demographic factors such as the level of education and income of households are positively correlated with adoption of CA practices and use of improved inputs.

In addition to demographic factors, the likelihood of sustained adoption of CA is correlated with the availability of technical support such as extension services, and infrastructural factors such as proximity to road networks and urban centres. Furthermore, results of past studies indicate that farmers tend to perceive CA as being appropriate for certain crops but ineffective or too expensive for other crop types, and as a result most farmers who practice CA will also continue to follow traditional cultivation practices on adjacent plots. Therefore, it is emphasised that the findings of past and ongoing research on the topic of CA in Mozambique should be interpreted conservatively given that findings are likely to be context-specific and not necessarily applicable across the full extent of Mozambique's heterogeneous agriculture sector. Nevertheless, common trends can be perceived between past initiatives focused on CA in the factors which influence the long-term adoption of CA by smallholder subsistence farmers, the most common of which are described below in Sections 4.1–4.7. Section 4.8 provides a synthesised summary of the primary factors which are likely to support sustained the adoption of improved or adaptive agricultural practices (primarily focused on CA) by smallholder farmers.

4.1 "The need to adapt CA to local context"

There is broad agreement between most CA researchers and project managers on the potential contribution of CA to the development of Mozambique's agriculture. However, there is less agreement on which approaches to CA, and under which environmental and social conditions, would be most relevant and effective for smallholder farmers (Grabowski et al., 2015b). The need for CA practices to be adapted to the local context of smallholder farmers has been well established in the literature (Giller et al., 2009; Wall, 2007). Results in several studies show that the majority agree that CA is useful for most smallholders in Mozambique but needs to be adapted to local conditions through research that is closely linked with farmers' reality (Grabowski et al., 2013). For CA to be effective in Mozambique, there is a need to understand context specificity and the perspectives and motivations of farmers (Grabowski et al., 2015a).

There are many biological and economic arguments in favour of low-input approaches as well as more technically complex or expensive approaches. Those who favour the increased use of inputs such as fertiliser, herbicide and pesticide, and improved crop varieties, tend to focus on delivering benefits based on increased yield and the subsequent increase in income from marketing larger volumes of produce. In contrast, those who favour low input approaches to CA emphasize the benefits of increased self-sufficiency and environmental integrity (Grabowski et al., 2015a). The divergence of views and perspectives of appropriate adaptation approaches among practitioners in the agriculture sector is a barrier to a coherent policy framework and best practices for promoting conservation agriculture and other climate-resilient approaches.

As described in Chapter 3.3 (above), the doctoral thesis of Nkala (2012) provides many useful insights about CA and livelihoods. For example, Nkala emphasizes how farmers are actively redesigning CA packages to fit their needs and asserts that a participatory approach to adapting the technology is more appropriate than a technology transfer approach. Despite the apparent challenges to assuring the sustained adoption of CA after the completion of a given CA project or initiative, Nkala's thesis study nevertheless includes a number of farmers who have voluntarily sustained CA approaches and who report tangible benefits to the practice. However, Nkala notes that in virtually all cases, those farmers who continue to practice CA have altered elements of the typical CA approach and discarded other elements according to their local context and circumstance (Nkala terms these modified approaches as 'distorted adoption' of CA).

With respect to those farmers who could be characterised as practicing a 'distorted' or redesigned approach to CA, Nkala's thesis suggests that there is a need for participatory research with farmers to understand the reasons for redesigning of CA practices, and how these revised practices could be incorporated into a coherent system for CA that can be promoted and transferred to other farmers if successful. Finally, the study recommends that future initiatives should adopt a more strongly participatory approach that includes farmers, extension agents and researchers in a collaborative effort to identify practical and innovative farming practices – rather than the conventional 'technology transfer' approach which promotes CA as a package of practices and principles.

With respect to those farmers who 'disadopted' (i.e. trialled and then discontinued application of the CA approach), Nkala's study includes an investigation of the factors which can be contributed to discontinuation. A general practical challenge noted in Nkala's 2012 thesis is the difficulty in controlling weeds using CA approaches, which can be attributed to factors such as the unfamiliar timing of weed emergence in CA compared to CF methods, the relatively high cost of herbicide and application equipment, and alternatively the high cost of hired labour to perform weeding manually. The cumulative effect of the aforementioned challenges and barriers is that farmers become

disillusioned with the CA approach, and therefore revert to conventional use of hoeing and tillage to control weeds (Nkala, 2012). As a result of these high costs for inputs and additional labour, the most vulnerable of smallholder farmers may be the least able to adopt the intended approach to CA. Similar trends are noted by other studies, where factors such as income, access to credit and availability of inputs are the primary barrier to sustained adoption of CA (detailed further below).

4.2 "Local decision-making is driven by short-term socio-economic vulnerabilities and poverty"

As described in Chapter 3.3 (above), the doctoral thesis of Nkala (2012) supports the case for the technical effectiveness of CA but also found that sustained adoption and upscaling of CA approaches was undermined by socio-economic factors such as vulnerability of agricultural households to loss or diversion of livelihoods, lack of access to agricultural assets and a lack of institutions supporting smallholder farmers. The authors note that as a result of the widespread socio-economic challenges that affect rural Mozambique, adoption of CA has a relatively limited impact on livelihoods through a slight improvement in crop productivity.

A 2015 study by Mouzinho et al. (2015) analysed the results of the annual agricultural survey from the 2010/2011 season to assess the factors which influence the use of improved inputs (*viz.* fertiliser, pesticide, herbicide and improved seed varieties) by smallholder farmers. In consideration of the relatively high cost of inputs relative to the average income of rural Mozambican households, it is unsurprising that factors such as access to credit, engagement in waged employment and household wealth (proxied by livestock ownership) were all associated with the use of improved inputs. The results of Mouzinho et al. (2015) are in line with the findings of similar studies (e.g. Nkala (2012), Rusinamhodzi et al. (2011).which found that the majority of CA-practicing farmers were from middle income households, and virtually none from the poorest and least-resourced farmers. This finding is in line with other observations in the literature which suggests that poor farmers are particularly risk-averse and may be unable to invest in sustained adoption of CA as a result of lack of capital/funds. In the latter households, immediate needs such as food purchases, transport and health care must be paid for with limited finance before the additional costs of adopting CA, such as purchase of agricultural inputs and hired labour, can be considered (discussed further in Chapter 4.3 below).

Nkala et al. (2011a, generated as an output of Nkala's 2012 thesis) found anecdotal evidence that the benefits of CA gradually increase over time and that farmers who practice CA tend to accumulate more household farming assets than farmers practicing traditional 'slash and burn' techniques. For example, "Some CA farmers have replaced their traditional mud houses with modern brick and cement houses, others have purchased livestock, bicycles, and furniture and household utensils from the proceeds of selling surplus". However, Nkala et al. emphasise that the connection between CA, household income and food security is weak and anecdotal. As described in 'Chapter 2.3 Financial capacity, household income and access to credit' (above) there is an inherent bias of CA-related initiatives towards the participation of comparatively wealthy farmers, members of farmers associations and other relatively well-resourced individuals – therefore these individuals are likely to have greater means to accumulate assets than their less well-resourced neighbours, irrespective of their preferences for CA. These findings suggest that the most vulnerable and impoverished households require sustained technical and financial assistance in order to transition to sustainable and self-reliant CA approaches, for the reason that these

households are reluctant or unable to risk the additional costs related to CA if the financial returns are not immediately apparent (discussed further in Chapter 4.6, below).

4.3 "Financial capacity, household income and access to credit"

A common theme throughout the literature on Conservation Agriculture is that the most impoverished agricultural households are simultaneously the demographic that most urgently requires the benefits associated with CA while also being the group that is least likely to sustain the adoption of CA techniques without continued technical and financial assistance.

Nkala *et al.* (2011) noted a trend towards relatively higher rates of adoption of CA by wealthier households, compared to households with an average or low income who were less likely to adopt and sustain CA management practices. This trend was partly attributed to an inherent bias of development initiatives towards selection of households with a relatively high level of education and/or income, which resulted in a disproportionate transfer of skills and inputs to practice CA towards wealthier households. However, in addition to this unintended bias towards wealthier households, it was suggested that the pressing socio-economic challenges which typically affect the most vulnerable subsistence farming households undermine the ability of these households to invest in the necessary inputs and land preparation for effective CA. A fundamental challenge that hinders the development of smallholder agriculture around the world, including countries such as Mozambique, is the lack of liquid cash or access to credit for farmers to purchase good-quality inputs, invest in marketing and transport of produce, prepare and plant a large enough area to generate surplus, or access crop insurance. As a result, limited access to credit and low capacity for financial management is commonly cited as a barrier to agricultural and rural development.

The aforementioned thesis study by Nkala (2012) provided several possible explanations for those farmers who 'disadopted' (i.e. discontinued the use of) recommended CA practices, which included "lack of resources by poor farmers compared to well-resourced research institutions" and "lack of access to credit". In the case of the farmers surveyed by Nkala's study, the CA practices demonstrated relied on applications of agrochemicals such as herbicides to control weeds. Furthermore, the proposed CA practices demonstrated to farmers required that farmers provide additional manual labour inputs for weeding compared to traditional practices for land preparation and weeding. As a result of these additional inputs, the poorest and most vulnerable households are unable to afford the inputs required to adopt the 'recommended' approach to CA. In consequence, farm yields may be negatively affected by competition with weeds and farmers are likely to become disillusioned with the perceived cost and labour-intensive nature of CA.

The aforementioned study by Mouzinho et al. (2015) found that among those farmers in Tete province that used fertiliser, the primary crops grown using fertiliser included maize (40% of fertiliser users), tobacco (38%) and potato (11%%). Among those farmers participating in tobacco farming (a relatively high-value cash crop), ~96% of growers used inorganic fertilizers. This shows a strong link between tobacco cropping and inorganic fertilizer use, possible explanations for which include: i) tobacco and other cash crops tend to have higher profitability than staple/subsistence crops, meaning that farmers who grow tobacco have additional funds to invest in new technologies compared to subsistence farmers; ii) the contract farming system used to engage many of the tobacco farmers in Tete facilitates access to inputs such as fertilizers; and iii) crops such as tobacco have an

assured market which reduces the exposure of producers to risk (Mouzinho et al., 2015).

4.4 "Local knowledge, awareness and technical capacity to adopt alternative agricultural practices" such as Conservation Agriculture

The study undertaken by Mouzinho et al (2015) observed that the level of education of the household head is positively correlated with the likelihood of continued adoption of new technologies or practices. For example, the level of education of household heads is associated with a stronger likelihood of using improved maize seeds and inorganic fertilizers. The household heads that used improved maize seeds have an average of four years of schooling, one additional year more than their counterparts (Mouzinho et al., 2015). In some respects this result is unsurprising in consideration of the close relationship between household income, access to credit and access to waged employment on one hand, and the likelihood of practicing some form of CA on the other hand. Therefore, if it is assumed that level of education is correlated with a relatively higher income or access to waged employment in Mozambique, it is unsurprising that farmers with a comparatively higher level of education are more likely to participate in development initiatives and experiment with new practices such as CA. However, an alternative explanation for the correlation between a farmer's level of education and the likelihood of practicing CA is that the measures currently used to promote and demonstrate CA may be inappropriate or ineffective for engaging the least educated households.

The research undertaken by Mouzinho et al (2015) found that the use of improved inputs such as fertiliser and maize was also positively associated with availability of extension services, as well as membership in a farmer's association. These results suggest that farmers benefit from access to technical advice and demonstration of new agricultural practices to support a participatory process of 'learning by doing'. The approach taken by Farmer Field Schools (described in Chapter 3.3) towards development of technical capacity of farmers through establishment of demonstration farms, engagement with extension agents and NGOs, has been shown to be a successful means of transferring new technologies and approaches to farmers. Furthermore, the outcomes of the CARE FFS projects indicated that farmers who sustained the application of CA practices with the provision of additional technical support from extension agents or NGO works were able to achieve higher yields and returns relative to conventional/traditional approaches. Consequently, the findings of the latter initiatives strongly support the case for increased access to modernised and well-equipped extension services.

4.5 "Access to enabling institutional environment and technical support"

The research paper entitled '*Tracing Agricultural Policies to Practices in Mozambique*' (IIED & CARE, 2016) provides several insights into the institutional factors which support as well as hinder the sharing of information and efforts to upscale Conservation Agriculture as well as other aspects of sustainable agriculture. At the field level, the limited or inconsistent availability of extension services is suggested to be a major barrier to upscaling of CA in Mozambique, which is recognised by the Government and partially addressed through the priority actions details in the PEDSA which include increased provision of extension services through both public and non-public channel. IIED&CARE note that donor agencies and international NGOs currently provide considerable extension services as well as support for training and supply of inputs and equipment, which is not considered to be a sustainable solution to safeguarding

Mozambique's agriculture sector or upscaling CA. Structural reforms to improve the coordination and collaboration between these diverse stakeholders have been introduced, particularly to strengthen national-level coordination and coherence between research and extension services. These newly-created structures for improved coordination include the Mozambique Platform for Agricultural Research and Technological Innovation (PIAIT) and the Directorate for Training, Documentation and Technology Transfer (DFDTT). In addition, the establishment of a Conservation Agriculture Working Group (CAWG) is noted as a useful platform for stakeholders to share research, best practices and lessons learned (IIED & CARE, 2016).

IIED&CARE (2016) suggest that the effectiveness of extension services (including extension provided by government, NGOs and international donors) will be strengthened if Government makes use of, and provides more active support to, the structures established to improve coordination with civil society and other stakeholders. Furthermore, Government's capacity and effectiveness will benefit from access to evidence, information and results generated by other stakeholders. Simultaneously, non-governmental stakeholders such as civil society, research organisations, donors and private sector are strongly encouraged to improve coordination and share results proactively.

As noted in Section 3.3 (above), the use of Farmer Field Schools (FFS) has played an important role in the demonstration and transfer of CA approaches by agencies such as CARE International, and the establishment of FFSs is noted to be increasing rapidly with governmental support. The relative success of the FFS approach to promotion of CA in Mozambique can be attributed to a bottom-up approach that encourages the active participation of farmers in decision-making (Grabowski et al., 2015b). As noted in Section 4.4 (above), FFSs provide a platform for demonstrating CA and building farmers' capacity to implement CA, in addition to providing a mechanism for training extension officers and including all stakeholders in participatory research approaches. As a result, it is suggested that the establishment of an appropriate enabling environment for successful replication and upscaling of CA will be greatly supported by strategically increasing the geographical coverage of FFS facilities to all agro-ecological areas.

An important element of the creation of enabling environment to support upscaling of the CA approach in Mozambique is the development of infrastructural and value chain linkages to increase availability and access of inputs for farmers. Missing or inefficient credit, input and output markets make it difficult for farmers to produce and sell cash crops. As a result, major cash crops require coordination mechanisms, such as contracting in the case of cotton, tobacco, and increasingly other crops, or vertical integration/plantation for sugar cane (Benfica and Mather, 2013). Also, researchers' and project managers' priorities indicate widespread recognition of the importance of linking actors across the value chain. However, Mozambique's value chains are relatively weak and undeveloped (Grabowski et al., 2015a) and as a result the poorest households are hindered by poor market access and limited bargaining power (both for selling produce as well as purchasing inputs). Access to inputs and markets by smallholder farmers is still considered one of the primary constraints to Mozambique's agriculture sector (IIED & CARE, 2016). As described previously (Chapter 4.4, above), researchers such as Mouzinho et al. have noted that access to credit tends to be significantly higher among those who used inorganic fertilizers and improved maize seeds, although the proportions of access to credit in general were low compared to neighbouring countries (Mouzinho et al., 2015). Smallholder farmers desire access to credit and should also be encouraged to use inorganic fertilizers for CA agriculture to be realized. Therefore, efforts to promote the sustained adoption of CA practices need to include consideration of the supporting institutional framework and marketplace to promote increased access to credit and finance, agricultural inputs and technical guidance. The

development of value chains for certain locally grown crops and livestock has been promoted and supported by various donors and NGOs, but is still very much below its potential. More effort is needed to develop appropriate value chains for smallholder farmers.

Nkala's 2012 study found that the tendency of farmers to redesign and alter CA practices points to a "lack of coherence between the farmers' needs and scientists' view of which technologies should work". While farmers appreciated the potential of CA, they tended to be skeptical as the package is too complex and too academic for real agricultural practice, as well as not adapted to their context and level of available resources". This finding supports the case for a participatory approach to developing and researching locally appropriate CA approaches which engages scientists and farmers as equal participants with active roles, as discussed and detailed in 'Section 4.1 The need to adapt CA to local context' (above). However, this finding also emphasises the need to develop the institutional framework, market linkages and access to technical support to provide services and inputs to smallholder and emerging farmers. As a result of the pressing socio-economic challenges and poverty that hinder the development of Mozambique's rural areas and smallholder farmer population, most farmers are likely to abandon CA practices after the termination of a project implementation period because farmers are not able to afford the inputs required by CA. Therefore, those poorest and least well-resourced farmers (who are among the most climate-vulnerable groups in the country) require additional financial and institutional support to be able to adopt CA. In the absence of such support, the most vulnerable and under-resourced farmers are likely to be left out of future initiatives and the benefits of CA are likely to be diverted to the already well-resourced farmers (Nkala, 2012). The analyses undertaken by Mouzinho et al. (2015) also found that improved inputs was significantly higher among male-headed households and households with more adults. As described above, the use of improved inputs was also associated positively with the level of education of the farmer, where those farmers with more than four years of schooling were more likely to use improved inputs. In addition to the level of education, factors such as the availability of extension services and membership in a farmer's association were also both strongly associated with the use of improved inputs. Therefore, there is a need to strategically identify opportunities and weaknesses in the current value chains and enabling environment which prevent easy access to credit, inputs and technical guidance by the poorest and most vulnerable farmers.

The changes required in agricultural and food systems require the creation of supporting institutions and enterprises to contribute to the transformation and commercialisation of agricultural value chains. There is widespread agreement among researchers and program managers about locally adapting CA, however, farmers' involvement in research is limited to managing researchers' experiments. In contrast, some NGOs work collaboratively with farmers through FFS to adapt conservation agriculture to the local context. What this means is that small-holders farmers have a bigger role in CA and are not be limited to the periphery in their own practice. The imperative is to bring farmers up to speed with CA so that they can be major players involved in collaboration with researchers and NGOs through well-defined supporting systems and enterprises (Grabowski et al., 2015a). There tends to be a wide social and cultural gap between formal researchers and resource-poor farmers, which must be understood and addressed in order to support successful collaboration between such different and diverse stakeholders. Consequently, Grabowski et al. (2015a) proposed that the responsibility for fostering bottom-up collaboration with farmers cannot rest on one institution and should be addressed using a multi-sectoral approach. The establishment of a national Conservation Agriculture Working Group

(CAWG) is noted as an effective approach for encouraging collaboration with researchers, NGOs and other stakeholders and will support MASA's efforts to promote participatory and collaborative innovations in agriculture.

4.6 "Need for a strengthened evidence-base" for the effectiveness of CA

Nkala et al. (2012) notes that the full benefits of CA are only realised after two or three years, and therefore the poorest and most vulnerable of farming households may not have the choice or incentive to wait for the accumulated benefits of sustained implementation of CA (for example, poorer farmers are unlikely to persist with CA techniques if they cannot purchase the necessary inputs). Even those farmers who agree that there are benefits to the CA approach and who continue to apply CA practices generally continue to practice traditional agriculture approaches and CA side by side on adjoining plots. This result suggests that even those farmers who practice the CA approach do not necessarily perceive the benefits of CA as being broadly applicable to all crops. Therefore, there is a need to strengthen the evidence-base for the effectiveness of CA in each agro-ecological zone so that successful approaches can be demonstrated (e.g. through Farmer Field Schools, farmer field days) and publicised (e.g. through printed pamphlets).

In a technical brief based on past CA initiatives, CARE International noted that farmers have a tendency to support those practices which result in observable benefits (such as reduced labour costs or increased productivity) and are unlikely to continue practices which are not perceived to result in tangible short-term benefits (IIED & CARE, 2016). As a result, any new initiative which aims to promote the adoption of CA must emphasise the identification of locally-appropriate strategies to increase productivity, reduce input costs or provide additional sources of income in the short term. The identification of short-term benefits will support the sustained implementation of CA practices for long enough for benefits such as increased soil fertility and improved water holding capacity to be realised by sceptical farmers.

A challenge frequently noted with respect to establishing an evidence-base for the effectiveness of CA is the agro-ecological variability of Mozambique, which results in the need to develop locally appropriate technologies and crop combinations and limits the usefulness of comparisons between results from different areas. The IIAM-published study entitled '*Literature Review and Research Gaps*' (Grabowski et al, 2013) provided a summary of priority research gaps and information needs related to CA, including biophysical research needs in each agro-ecological zone. In particularly, the study emphasises the need to undertake basic agronomic studies to evaluate the performance of CA approaches relative to conventional tillage in each agro-ecological zone, to address the current gaps in geographical coverage. The primary value of the evidence base presented in those studies summarised in Chapter 3.3 is to inform policy-makers and technocrats of the most successful methods which can be promoted for replication and upscaling in each agro-ecological zone.

4.7 Factors influencing the use of improved inputs by smallholder farmers in central Mozambique, based on analysis of National Agricultural Survey 2010/11

In 2011, a survey on price dynamics in the agriculture sector was carried out by Michigan State University (MSU) in collaboration with the Ministry of Agriculture (formerly MINAG, now MASA) and was used as the basis for a meta-analysis of the demographic factors which characterise farmers who use improved inputs (i.e. improved seed varieties, fertiliser, pesticide and herbicide)

(Mouzinho et al 2015). The authors noted that, despite the relatively low proportion of farmers who use improved inputs as a national average, there are relatively high rates of use of inputs in districts and provinces with strong agricultural potential. For example, the National Agricultural Survey (*Inquérito Agrícola Integrado*) of 2012 estimated the proportion of smallholder farmers who use inorganic fertiliser as a national average as ~3%, however the local rate of fertiliser use is estimated to be over 33% in Tete province. Similarly, the national usage of improved maize seeds is estimated to be ~9%, however this proportion is estimated to be over 30% in Manica province. The authors observe that these relatively high local rates of adoption of improved inputs (while acknowledged to be unrepresentative of the national status quo), are comparable to the national average rate of adoption in neighbouring Malawi (30%) and Zambia (32%). However, an important difference between the latter nations and the Mozambican provinces of Manica and Tete is that the comparatively high rate of use of inputs in the latter two nations can be attributed to extensive national programmes to subsidise agricultural inputs, whereas Manica and Tete provinces benefitted from no such initiatives. The GoM introduced an initiative to distribute vouchers for agricultural inputs through the Action Plan on Agricultural Production (PAPA) in the period 2008–2011, however it is estimated that only ~1% of households in Manica and Tete received vouchers, therefore discounting "the possibility that input subsidy has been the main factor in the high levels of input use observed in Manica and Tete" (Mouzinho et al., 2015).

The authors suggest several explanations for the above-average use of inputs in the Tete and Manica provinces, including inter alia: i) geographical proximity to the Malawian border, allowing Mozambican farmers to travel across the border to purchase subsidised inputs in Malawi; and ii) recent initiatives focused on development of the local market for agricultural inputs, which led to the introduction of small packages (1-5kg) of improved seed and fertiliser which could be accessed by poor households with limited means to purchase larger input packages (Mouzinho et al., 2015).

In summary, the results indicated that the adoption of CA approaches such as the use of improved inputs is most feasible and sustainable for those farmers who have: i) the means to invest in improved inputs; ii) access to information and guidance of other farmers, experts, and extension workers; and iii) technical capacity and education to interpret and adapt successful approaches to their context. The authors' recommendations to promote the sustained and upscaled adoption of improved inputs included increasing access to input markets and information for farmers by actions such as: i) development of market linkages and implementation of targeted programmes to increase smallholder access to inputs; ii) promotion and strengthening of market linkages for cash and staple crops as a means of increasing household income and financial capacity; and iii) expanded investment in public services and infrastructure, particularly in sectors such as transport and electricity (Mouzinho et al., 2015).

4.8 Summarised best-practice measures to support sustained adoption and upscaling of Conservation Agriculture

Analysis of the outcomes and lessons learned by the past and ongoing initiatives summarised in Section 4.1–4.7 indicates that there are several common factors which support successful, sustained adoption of adaptation practices such as CA despite Mozambique's socio-economic and agro-ecological heterogeneity. 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 Mozambique's rural communities. Therefore, while

it is apparent that the technical feasibility and agronomic performance of various CA practices is highly context- and site-specific, many of the factors which support the sustained adoption of new agricultural or adaptation practices appear are widely applicable across Mozambique.

Through the identification of these common factors, recommendations can be generated to enable more effective climate adaptation responses that work and increase resilience for the most vulnerable in the context of the original research question.

Figure 6, below, provides a graphical depiction of the major factors identified by the stakeholders and studies consulted during the course of the research project which influence or support the sustained adoption of agricultural and adaptation practices such as CA in Mozambique. Table 1, overleaf, summarises the rationale behind each of the factors identified and provides recommendations of good practices and actions to be prioritised by ongoing and future initiatives aiming to promote CA and other adaptation actions in the agriculture sector.

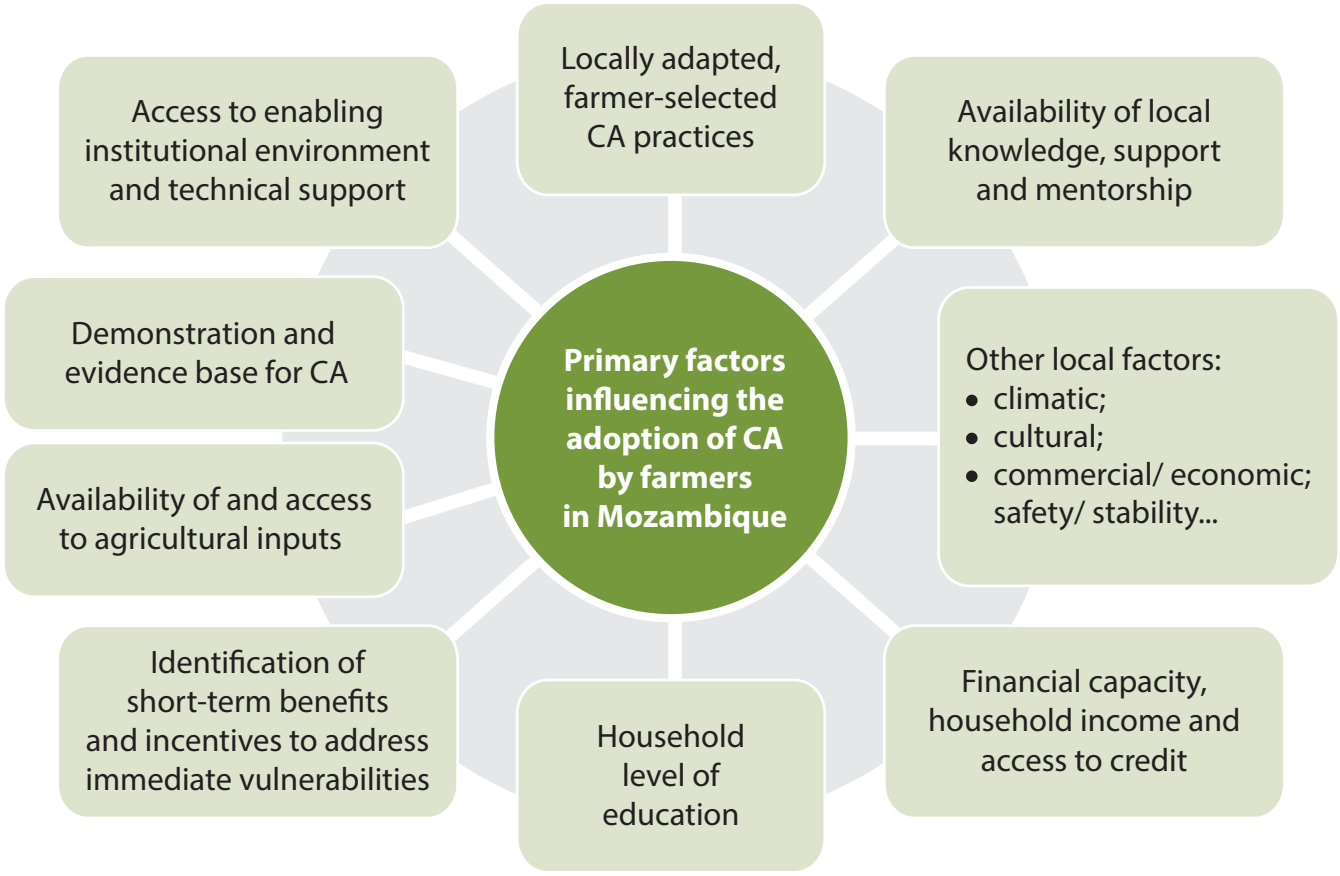


Figure 6 Primary factors which influence or support the sustained adoption of agricultural and adaptation practices such as CA in Mozambique

Table 4 Identification of primary factors and recommended practices which promote the sustained adoption of agricultural and adaptation practices such as CA in Mozambique

Factors to promote sustained adoption	Rationale	Recommended practices
Locally-adapted, farmer-selected CA practices	• CA is useful for most smallholders in Mozambique but needs to be adapted to local conditions. • Farmers are actively redesigning CA packages to fit their needs. • Those farmers who continue to practice CA voluntarily have typically altered or discarded certain elements according to their local context and circumstance.	• Identify local practices, local sources of knowledge and expertise. • Prioritise participatory approaches that include farmers, extension agents and researchers in a collaborative effort to identify locally appropriate practices – rather than the conventional 'technology transfer' approach which promotes CA as a package of practices and principles. • Study/investigate the local-level factors which contribute to discontinuation of recommended CA practices.
Identification of short-term benefits and incentives to address immediate vulnerabilities **Adequate financial capacity, household income and access to credit for purchasing inputs and labour**	• Impoverished rural farmers respond to immediate economic vulnerabilities and poverty over long-term benefits and incentives to adopt CA. • Sustained adoption and upscaling of CA approaches is undermined by socio-economic factors such as vulnerability of agricultural households to loss or diversion of livelihoods, lack of access to agricultural assets and a lack of supporting institutions. • The relatively high costs of herbicide, application equipment, and hired labour to perform weeding manually may cause farmers to become disillusioned with the CA approach and therefore revert to conventional hoeing and tillage before benefits of CA can be accrued. • Poor farmers are particularly risk-averse and will prioritise immediate needs such as food purchases, transport and health care over the additional costs of adopting CA, such as purchase of agricultural inputs and hired labour. • Households with average or low income are less likely to adopt and sustain CA management practices. • Low-income and subsistence farmers are less likely to use improved inputs than high-income farmers, outgrowers (e.g. tobacco) and cashcrop growers. • Limited access to credit and low capacity for financial management is a barrier to agricultural and rural development in general.	• The most vulnerable and impoverished households require sustained technical and financial assistance in order to transition to sustainable and self-reliant CA approaches. • Identify feasible practices that are appropriate to the farmer's level of financial capacity, accessibility of credit access and inputs etc. • Identify practices that generate tangible near-term benefits to incentivize continuation of CA e.g. generation of additional income through cultivation of cash crops, improved food security and nutrition through diversification of staple crops. • Provide additional assistance to those impoverished farmers who cannot sustain CA practices without support while encouraging self-sufficiency for those farmers with middle-to-high incomes. • Capacity-building and training for farmers should include a focus on basic financial management and promoting increased access to credit. • Identification of locally appropriate low-input OR high-input methods for CA should consider the capacity of the farmer to continue financing the recommended CA inputs on an ongoing basis

Availability of local knowledge and expertise, mentorship and support networks	• Education level of the household head is positively correlated with likelihood of adopting new technologies or practices such as use of improved inputs. • The measures used to promote and demonstrate CA may be inappropriate or ineffective to engage the least educated households. • Use of improved inputs is positively associated with availability of extension services and membership in a farmer's association. • Access to technical advice and demonstration of new agricultural practices supports participatory learning. • Farmers who sustained CA practices with additional technical support from extension agents or NGO workers achieved higher yields and returns.	• Prioritise the participation of farmers and communities that belong to cooperatives and farmer's clubs to encourage a 'horizontal' transfer of knowledge and experience within existing farmers' networks. • Identification of locally appropriate methods for CA should include consideration of the level of education, literacy and income at the household level. • Prioritise and upscale the use of participatory methods of demonstrating and teaching CA through Farmer Field Schools and related approaches. • Strategically prioritise the expansion of the national network of agricultural extension agents, supporting NGO workers and demonstration farms to under-represented geographic areas.
Access to enabling institutional environment and technical support	• Limited or inconsistent availability of extension services is a major barrier to upscaling CA in Mozambique. • Donor agencies and international NGOs currently provide considerable extension services as well as support for training and supply of inputs and equipment. • Bottom-up collaboration using a multi-sectoral approach in collaboration with stakeholders such as the national Conservation Agriculture Working Group (CAWG), the Platform for Agricultural Research and Technological Innovation (PIAIT), the Directorate for Training, Documentation and Technology Transfer (DFDTT) and local Farmer Field Schools (FFS).	• Identify opportunities and weaknesses in the current value chains and enabling environment which prevent easy access to credit, inputs and technical guidance by the poorest and most vulnerable farmers. • Promote an appropriate enabling environment for successful replication and upscaling of CA by strategically increasing the geographical coverage of FFS facilities to all agro-ecological areas • Promote the development of infrastructural and value chain linkages to increase availability and access of inputs, credit and finance, and technical guidance.
Availability of, and access to, good quality agricultural inputs	• The use of improved inputs is most feasible and sustainable for those farmers who have: i) the means to invest in improved inputs; ii) access to information and guidance of other farmers, experts, and extension workers; and iii) technical capacity and education to interpret and adapt successful approaches to their context.	• Promote access to input markets and information for farmers • Develop market linkages and implement targeted programmes to increase smallholder access to inputs; • Improve market linkages for cash and staple crops to increase household income and financial capacity; and • Invest in public services and infrastructure in sectors such as transport and electricity.

Demonstration of an evidence base for the effectiveness of CA	• Farmers support practices which result in observable benefits (e.g. reduced labour costs or increased productivity) • Identification of short-term benefits supports sustained implementation of CA practices so that long-term benefits such as increased soil fertility and improved water holding capacity will be seen by sceptical farmers. • Need to strengthen the evidence-base for the effectiveness of CA in each agro-ecological zone so that successful approaches can be demonstrated and publicised.	• Identify locally appropriate strategies to increase productivity, reduce input costs or provide additional sources of income in the short term. • Strengthen the evidence-base for the effectiveness of CA in each agro-ecological zone so that successful approaches can be demonstrated (e.g. through Farmer Field Schools, farmer field days) and publicised (e.g. through printed pamphlets.

4.9 Diverse perceptions and perspectives on CA in Mozambique

Despite the sustained and widespread promotion of CA in Mozambique by stakeholders including national government, international development agencies, non-governmental organisations and private sector companies, there still remains several areas of disagreement on what principles and practices are included in the definition of 'Conservation Agriculture'.

In two related reports, Grabowski et al (Grabowski et al, 2015a; 2015b) described the results of a series of surveys of project managers and consultants participating in CA projects in Mozambique, the results of which highlighted the different opinions and perspectives on the importance of low-input versus high-input systems. The two primary points of disagreement noted by the aforementioned studies relate to: i) the relative importance and emphasis of minimum tillage and soil conservation; and ii) the role to be played by commercial inputs such as agrochemicals, improved seed varieties and mechanical seeding equipment. Based on repeated interviews with ~24 program managers, the study noted differences in perspective on the relative importance of the use of modern improved inputs in CA. For example, certain stakeholders strongly believed that inputs such as fertilizer, herbicides and improved seeds are critical inputs to modernise the smallholder agriculture sector. In contrast, other stakeholders perceive commercial inputs to be problematic or impractical, for reasons such as potential negative impacts on the environment, and logistic challenges that limit the accessibility of these inputs to smallholder farmers.

Grabowski et al's 2015 study of CA program managers included questions on the relative importance and relevance of various commercial inputs (fertiliser, herbicide and improved seeds) as part of CA best practices. Summarised immediately below and in Table 2 are some of the responses from the program managers which highlight the sometimes-contradictory views of national CA experts in Mozambique:

- one third of the respondents (eight out of 24) stated that, without the abovementioned inputs, CA was not feasible;
- five out of 24 respondents stated that low-input CA was feasible, pointing out that most farmers in Mozambique do not have easy access to inputs;
- remaining respondents noted that even those CA approaches which do not include use of purchased inputs can have beneficial results (Grabowski et al, 2015b).

Table 5 CA program managers' perspectives on the importance of commercial inputs

Rating	Fertilizer	Herbicide	Seed
1. Not Important	5	4	6
2.	1	2	1
3. Somewhat Important	8	9	9
4.	5	3	0
5. Very Important	4	4	5
Rating Average	3.09	3.05	2.86
Response Count	23	22	21

Adopted from: Grabowski et al., 2015b

These opposing viewpoints and perspectives among the CA project managers surveyed can partly be attributed to the diversity of techniques, crops and agro-ecological zones included in the range of CA projects undertaken in Mozambique. As noted previously, an inherent challenge in analysing the impacts and effectiveness of CA in Mozambique is the broad range of definitions of practices, principles and technologies that can be considered 'Conservation Agriculture'. Furthermore, considering the often-repeated observation that locally appropriate CA practices must be identified, trialled, and improved in participation with farmers, it is unsurprising that there is disagreement between project managers from different regions on the relative effectiveness of various CA approaches. For example, in Grabowski et al. 2015b, it was noted that in the second round of surveys there were contradictory views on which agro-ecological zones would be most appropriate for promotion of CA. Certain respondents viewed CA as being particularly useful for marginal areas characterised by unproductive soils or poor rainfall, where benefits of CA such as increased water conservation and soil fertility could improve the performance of unproductive agriculture. Conversely, other respondents suggested that CA is most appropriately promoted in areas with high agricultural potential where yield benefits can be realised rapidly.

Despite the abovementioned contradictions and differences in perspective between the various CA project managers surveyed, there are nevertheless several principles which are broadly agreed to by most or all stakeholders. Most respondents agreed that the existing CA technologies, approaches and practices are not ready for widespread national upscaling, for the reason that farmers must first be involved in the process of localised adaptation. Similarly, most respondents agreed that CA has the potential to generate benefits for smallholder farmers on the pre-condition that farmers have easy access to adequate technical support and capacity-building. The respondents universally acknowledge and agreed on the importance of adapting CA approaches to the local context, such as identification of the preferred local methods for land preparation (manual labor vs. animal traction vs. mechanical tractors) when developing alternative improved CA techniques.

In terms of needs for research and development activities, respondents were typically in agreement on priority needs and gaps to be addressed, including *inter alia*: i) adoption/disadoption studies in different agro-ecological zones; ii) farmer-led development initiatives and long-term participatory projects; iii) long-term agro-economic and soil science studies on the effect of CA.

4.10 Research gaps and information needs to promote and upscale Conservation Agriculture in Mozambique

Research gaps and priorities

Past studies and initiatives have included efforts to assess and identify research priorities and information gaps related to CA in Mozambique. The findings of several such studies, and the priority gaps and information needs identified, are described further below.

The *Agricultural Research Institute of Mozambique (IIAM)*, through the USAID-supported Platform for Agricultural Research and Technology Innovation (PARTI), is the source of several reports which summarise the extent of efforts towards promotion of CA, as well as identification of research gaps, priorities and opportunities. An approach commonly included in these studies is the use of expert presentations followed by facilitated discussions among expert stakeholders to identify research/information priorities, 'next steps' and best practices, which was the focus of the '*Future of Conservation Agriculture in Mozambique*' workshop and subsequent synthesis report in 2012. The aforementioned workshop was attended by approximately 70 participants from local and international agencies participating in research or promotion of CA in Mozambique. The discussions and findings of this workshop generated a number of priorities and information gaps that are reflected in subsequent research undertaken in the period 2012–2017, however the majority of the research priorities and information gaps remain relevant and at best only partially addressed at the present time (IIAM, 2012).

The synthesis report of the workshop proceedings noted that there still remained major gaps "in respect to research and promotion of CA technology" despite the ongoing activities of multiple organizations working simultaneously in the promotion and research of CA approaches in Mozambique (IIAM, 2012). It was suggested by participants that the low rates of adoption of CA are partially attributable to the short-term nature of most projects – for example, in instances where the agro-ecological benefits of CA approaches take several years to accrue, or where farmers cannot afford the purchase costs for CA inputs (e.g. agrochemicals, seeds), farmers are likely to return to traditional methods after the project implementation period has ended. Despite the general observation that adoption of CA remained relatively low despite the sustained efforts to promote the practice, a major gap in research and knowledge noted by the workshop participants is the difficulty in accurately quantifying the rate of CA adoption (IIAM, 2012). Therefore, it was recommended to prioritise research on the social, economic and biophysical factors which influence farmer decision-making on CA. As a result, it was suggested to include questions in the annual TIA agricultural survey that would allow evaluation of CA adoption rates. In terms of agronomic and biophysical research needs, the workshop participants highlighted the need for detailed and accurate cost:benefit analyses of CA for comparison with traditional approaches. Other important biophysical research gaps noted included the need to identify suitable cover-crop combinations for different agro-ecological zones, taking into account considerations such as identifying allelopathic species that will suppress weeds, nitrogen-fixing species to improve soil fertility, and the need to identify CA systems that are compatible with livestock production (IIAM, 2012).

As a result of the findings and recommendations of the abovementioned workshop, a number of subsequent studies and updated stocktaking reports were undertaken by IIAM and collaborating institutions. In one such study, Grabowski and Mouzinho authored a '*Conservation Agriculture Inventory Report*' that summarised the efforts and experiences relating to CA in Mozambique at that time. In this particular study (Grabowski and Mouzinho, 2013), the authors made several important observations relating to information and research gaps relating to CA in Mozambique.

One important issue, well-aligned with the observations of other recent studies, is the need to develop a broad and nationally-applicable definition of "Conservation Agriculture". Grabowski and Mouzinho (2013) noted that a survey of ~20 project managers participating in CA-related initiatives provide multiple and contradictory definitions of CA, indicating that there are gaps and inconsistencies between and within organisations working to

promote CA. Also well aligned with the findings of other studies (such as Grabowski et al, 2013, described below), Grabowski and Mouzinho noted that the effectiveness of various CA approaches varies widely between and within Mozambique's regions and crop types. Consequently, there is a well-described need to increase the geographical coverage of research into the socio-economic and biophysical effects of CA in each of Mozambique's agro-ecological zones, and to identify appropriate and effective practices for CA at a local scale.

Similar to the aforementioned report, IIAM published the study entitled '*Literature Review and Research Gaps*' by Grabowski et al (2013) which included several phases of participatory stakeholder-driven identification of research gaps and information needs related to CA. The authors categorised the wide variety of information needs and research gaps into two categories, namely 'biophysical' and 'socio-economic', and identified those priority research gaps that should be addressed in order to assess how CA can be used to benefit smallholder farmers. The summarised research gaps identified by Grabowski et al (2013) are presented in Table 3, below. Figure 7, below, presents the research gaps in the context of the implications for stakeholders ranging from farmers and field workers, to national-level decision-makers and planners.

Table 6 Priority gaps in socio-economic and biophysical research on CA in Mozambique

Theme	Research gap
Socio-economic	Studies to understand farmer decision-making and incentives to adopt CA compared to conventional approaches, including thorough analysis of gender impacts and seasonal labour changes.
	Studies on how CA is promoted to farmers and the relative successes of different extension/ education approaches, including cost-effectiveness and the long-term benefits of building farmers' capacity to learn and adapt.
	Large-scale adoption study would be useful for charting progress on CA adoption across the country and for characterizing adopters and non-adopters (including a focus on gender dimensions) to understand the barriers and constraints to more widespread adoption.
	Long-term study to assess the impact of CA approaches on farmers' livelihoods, by establishing a baseline in a new area before the introduction of CA and continuing over the course of 5 or more years.
Bio-physical	(in each agro-ecological zone) basic agronomic studies, especially regarding plant populations, fertilization rates, cover crops, rotations and weed control strategies.
	(in each agro-ecological zone) comparison of the performance of CA relative to conventional tillage systems.
	(in each agro-ecological zone) assessment of different manual reduced tillage and planting systems (basins, jabplanters, dibble sticks, "Chinese" hoe etc.) for different cropping systems.
	Investigate changes in soil organic matter (SOM) using CA approach for cassava, particularly regarding the permanence of SOM after soil disturbance from harvesting.
	Quantification of environmental services.

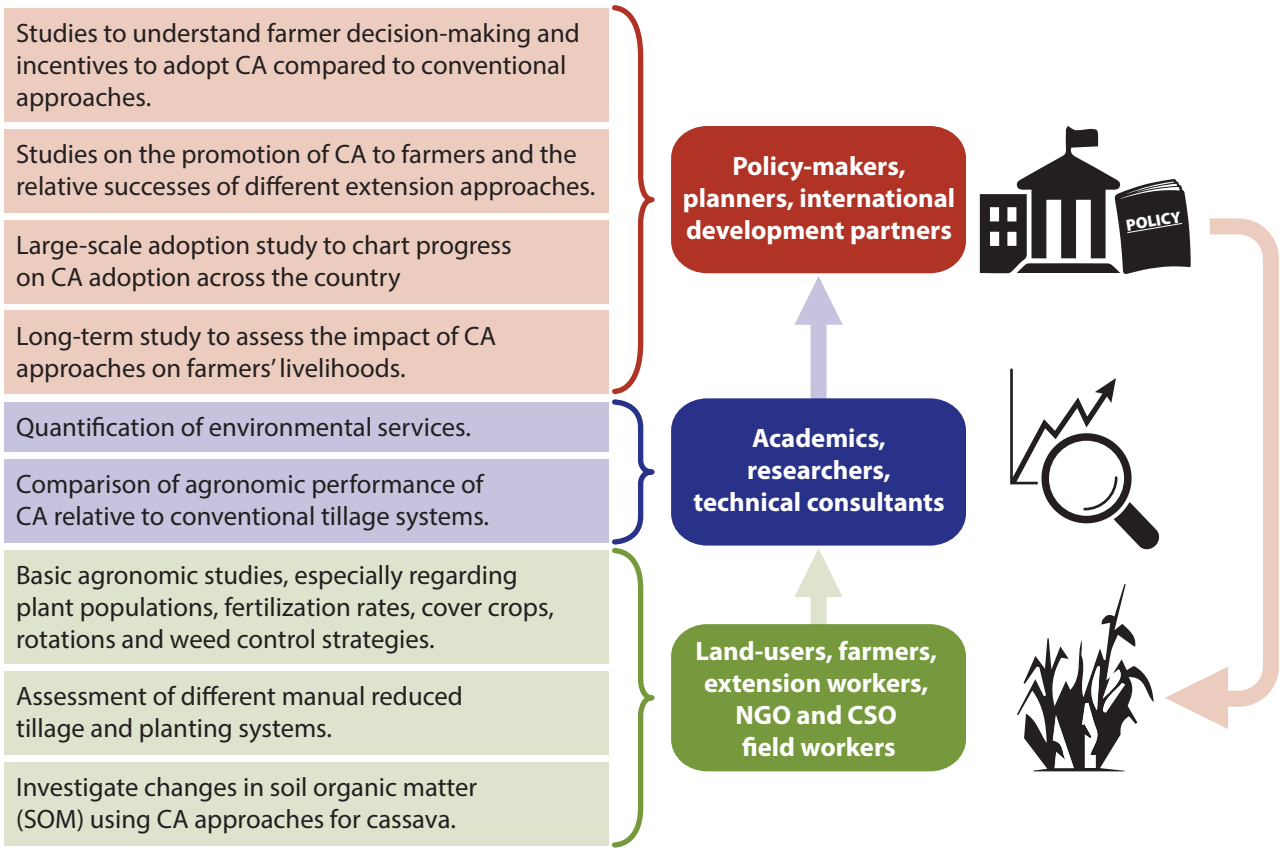


Figure 7 Research priorities for various stakeholders participating in the upscaling of CA in Mozambique

With respect to specific agronomic research needs, IIED&CARE note that there are still large gaps in knowledge and information required to guide decision making and priority setting at all levels. Priority information gaps to be addressed by research, and through improved sharing of information and best practices between stakeholders in areas with similar agro-ecological zones or with similar socio-economic conditions, include *inter alia* identification of locally appropriate cultivars and crop combinations, performance of different crops and CA technologies and integration of farmer innovations and traditional knowledge. Results from research at the CARE Farm Field School indicate that farmers tend to adopt those techniques which provide a high degree of 'observability' and offer immediate benefits. As a result, future efforts to promote CA should emphasise the identification of CA practices which will result in quick generation of observable benefits to encourage farmers to continue with the prescribed CA practices for long enough to perceive long-term benefits.

Recommended approaches to participatory research

One of the most recent studies published by the IIAM's Directorate of Training, Documentation, and Technology Transfer had an explicit focus on analysing the challenges and opportunities related to investing in promotion of CA and related approaches, from the perspective of MASA and its development partners. The study entitled '**Prospective Analysis of Participatory Research on Conservation Agriculture in Mozambique**' by Grabowski et al (2015b) does not provide an itemised list of priority research gaps, but rather aims to emphasise the need to increase the active participation of farmers in design and implementation of CA research. Further, the study outlines the complexities of participatory research and collaboration between different actors across the entire agricultural value chain, such as managing the different perspectives between advocates of high-input vs. low-input approaches to CA. Similar to the findings of Grabowski and Mouzinho (2013,

described above), Grabowski et al. (2015b) note that all efforts to promote or undertake research on CA must be aware of and manage any potential disagreement on two key issues, specifically: i) agreement on the emphasis on soil conservation and minimum tillage principles as part of the technical definition of CA; and ii) the relative importance and effectiveness of high-input approaches (e.g. approaches which include purchased agrochemicals, improved cultivars, specialised planting machinery) versus low-input approaches (e.g. approaches based on easily available and cost-effective inputs, increased emphasis of manual labour inputs and mulching for weed control rather than herbicide). The authors note that the apparent benefits of different CA approaches are widely variable across Mozambique's diverse rainfall regimes and soil types and requires that locally appropriate CA approaches need to be adapted to local context as part of the innovation process facilitated by participatory research. The study recommends that highly participatory approaches to agricultural research should be the priority for efforts to develop and promote appropriate CA technologies in Mozambique (Mouzinho et al, 2015b).

The authors note that while it is generally acknowledged and agreed that stakeholder participation is an important principle but that in practice the extent to which farmers are involved in research varies widely across a continuum of participation. At one end of this continuum, the participation of farmers can be described as a 'contractual' role, where farmers are effectively contracted to manage the experiments of another researcher. At the opposite end of the spectrum, the role played by farmers can be described as 'collaborative' (where researchers and farmers collaborate as partners to design, implement and analyse research) or 'collegial' (where researchers act to strengthen the farmer's own systems for research and problem solving). The authors acknowledge that there can be no single ideal approach, but that rather the appropriate approach to participatory research should be determined based on the information needs of the underlying problem. In the case of participatory research on CA in Mozambique, which is influenced by diverse socio-economic and technical factors at a local scale, the authors strongly recommend pursuing an equitable and collaborative approach. "When agricultural innovations require intimate familiarity with the farmers' context and advanced technical knowledge from researchers, collaboration is essential for effective problem solving" (Grabowski et al, 2015b).

CARE International is an NGO which has been particularly active in promoting the adoption of sustainable agricultural practices in general and CA in particular (see Chapter 1.3, above). Past project activities of CARE have included extensive direct engagement and training of farmers, undertaking research on the biophysical and socio-economic dimensions of CA, and investigating the state of implementation of existing CA policies and strategies at a national level. The CARE research paper entitled '*Tracing Agricultural Policies to Practices in Mozambique*' (IIED & CARE, 2016) provides a summary of the current status, and the recommended next steps, for upscaling Sustainable Agriculture principles across Mozambique (including a strong emphasis on CA approaches, which are considered to be one aspect of sustainable agriculture).

In terms of institutional-level needs to support effective research on CA, IIED&CARE note that several structural and organisational reforms have been introduced to strengthen the links at national level coordination and coherence between research and extension services. These include the creation of the Mozambique Platform for Agricultural Research and Technological Innovation (PIAIT) and the Directorate for Training, Documentation and Technology Transfer (DFDTT). The increased political support and promotion of CA in Mozambique will require increased coordination so that efforts are complementary and do not cause confusion due to inconsistencies in the

approach or techniques being promoted. In line with the findings of '**Prospective Analysis of Participatory Research on Conservation Agriculture in Mozambique**' (Grabowski et al, 2015b), IIED&CARE recommend a broadly participatory approach to training and research that emphasises the involvement of public advisory staff in training and implementation, including through the integration of FFS and other successful approaches into the curriculum of advisory training programmes. The establishment of structures such as the DFDTT provide an opportunity to support such an approach to participatory research and training, however at present it is unclear how these modalities would be coordinated at provincial and district levels to support the participation of locally active stakeholders such as NGOs and farmer's associations/groups. As noted previously (Chapter 2), the establishment of the Conservation Agriculture Working Group (CAWG) is a positive development that will support and improve the coordination between various CA researchers and practitioners. However, IIED&CARE note that currently the CAWG does not yet play a prominent role and it is recommended that members identify and implement new actions to increase coordination with other groups and platforms, such as the PIAIT.

PART III

Information and Knowledge Products to support the adoption of Conservation Agriculture in Mozambique

5 Knowledge products, publications and training materials to inform stakeholders on adaptation practices (particularly Conservation Agriculture) in Mozambique's agriculture sector

Within the broad range of stakeholders participating in the promotion and adoption of Conservation Agriculture in Mozambique, there exists a wide range of information needs from the national/central level down to the local/field level. Stakeholders participating in the agricultural value chain include individual farmers, farmers unions and cooperatives, extension officers, private buyers of agricultural commodities, local administrators, academic researchers and centralised policy-makers – each with specific needs for information and knowledge related to CA practices.

As a result of the continued promotion of CA in Mozambique since the mid-1990's, the country has developed a significant body of experience and technical capacity on the implementation of field practices for CA (for example, within academic researchers at universities and public research institutes such as IIAM, within experienced extension officers and policy-makers within MASA, MITADER and MAE, and within NGOs and international agencies). In addition, as a result of the country's proactive participation in international forums for financing and prioritising actions to counter climate change, there are well-established mechanisms and precedents for project-based promotion of CA as an adaptation response to climate change through government, multilateral agencies and NGOs. Finally, the country has benefited from sustained efforts to strengthen and harmonise the institutional and policy framework to support a coordinated, effective national response to climate change – particularly within the economically critical agriculture sector. However, despite the positive developments in technical capacity, institutional framework and political will, there remain some gaps in the availability of public knowledge and information that may undermine Mozambique's aim to upscale CA approaches across the entire agriculture sector.

Information and knowledge needs:

At the level of national and provincial decision-making and implementation of policies, stakeholders have a need for information and knowledge products that analyse the effectiveness, costs and sustainability of different CA approaches and related adaptation practices in the agriculture sector. Strategic investments in the climate-resilient development of Mozambique's rural smallholders and agriculture sector must be informed by a clear evidence-base for the reported effectiveness and co-benefits generated by CA approaches, as well as a proven methodology for demonstrating and promoting successful approaches.

In terms of the needs of initiatives aiming to promote and demonstrate CA practices at the field level, stakeholders have a need for information and knowledge products relating to technical and agronomic information on locally-appropriate CA practices (*inter alia* field guides and extension manuals), as well as material to support effective training and capacity-building of extension officers, Farmer Field School trainers and participating farmers. At the village- and household-level, the needs for information and knowledge products for farmers who have adopted, or are considering

adopting, CA approaches are diverse and multi-dimensional. In terms of technical information on how to adopt/integrate CA approaches, the majority of farmers are likely to require extensive capacity-development and technical support to identify and apply locally-appropriate CA approaches, as well as general awareness-raising and sensitisation towards the challenges posed by climate change to traditional farming approaches. In addition to the detailed and context-specific needs for technical information and knowledge products across Mozambique's heterogeneous agro-ecological zones, the complexity of local-level information needs is further increased by the diversity in languages, infrastructural development, literacy and access to media across the country.

Information and knowledge products identified:

One of the objectives of research undertaken over the duration of this study was the identification of published and publicly available products that collectively contribute to the body of information and knowledge on the promotion of CA as an adaptation response to climate change, particularly through government, multilateral agencies and NGOs in Mozambique. These products were identified in consultation with stakeholders interviewed and surveyed over the course of the research project. Specifically, stakeholders identified all known information sources and knowledge products based on the following question: "*Please identify all knowledge products that you are aware of, that can be used to inform/guide recent initiatives related to awareness of, or adoption of, conservation agriculture and climate-smart agriculture?*".

The range of information and knowledge products identified included *inter alia* field manuals and training guides (targeting stakeholders such as extension officers, field workers and trainers aiming to transfer practical principles of CA to farmers – described in Chapter 5.1); climate forecasts and agricultural market updates (targeting farmers, agricultural cooperatives and wholesalers aiming to plan for the weekly and seasonal variability in crop forecasts and market prices – described in Chapter 5.2); and annual survey data (targeting researchers and policy-makers aiming to understand the effectiveness and rate of adoption of various agricultural practices – described in Chapter 5.3).

Assessment of information and knowledge products identified:

The information and knowledge products identified by the study, presented in Chapter 5.1-5.3, are described and assessed according to some of the considerations below (where relevant):

Relevance and Applicability

A frequent challenge to the generation of effective information and knowledge products is the development of an appropriate, relevant and timeous format that is tailored to the specific needs and capacity of the target audience. The level of education, literacy and technical capacity to identify and adopt new technologies varies widely between stakeholders such as farmers, extension workers, researchers and policy-makers. Consequently, the appropriate level of technical detail provided and the methods used to communicate new approaches (for example, when describing alternative methods for *inter alia* soil preparation, planting, weed & pest control) should be informed by the needs and capacity of the specific target audience.

Availability and Accessibility

In some cases, a specific challenge relating to knowledge and information on CA is the issue of accessibility, rather than availability. For example, a common shortcoming noted with respect to training manuals and guidelines for CA is that, despite such materials being freely available for download from the internet, the intended target audience (i.e. rural smallholder farmers) typically do not have access to internet, computers

or printers. The distribution of hard-copy (i.e. printed) knowledge products such as training guides to the intended target audience is expensive and logistically difficult. As a result, the primary application of these useful knowledge products may largely be limited to well-resourced researchers, project practitioners and government officers with adequate office resources and infrastructure. A further challenge to the accessibility of existing knowledge and information is the widespread challenge of literacy and fluency in Mozambique's many spoken languages. The majority of knowledge products are published in Portuguese, which is the most frequently spoken *lingua franca* and the official language of government. In addition, many studies and documents which were generated by international agencies have been published in English as well as Portuguese. However, there appears to be a general lack of published knowledge products in any of the other local languages at a regional or provincial level.

Accuracy and Timeousness

The development of the agriculture sector, among several other large economic sectors, is strongly dependent on the availability of accurate downscaled information on weather and climate. The specific needs include local-level climatic data to inform assessments of agronomic potential for different crops, as well as short-term and seasonal weather forecasts to inform the planning of the farming calendar (including selection of crops as well as planning activities such as land preparation, planting and likely harvest time). In the absence of reliable and updated information, stakeholders such as farmers, outgrowers, agro-commodity buyers etc. are unable to make informed decisions on activities such as choice of crops/cultivars, timing of land preparation and planting, and likely yield. Similar to the challenge of accessing accurate and timeous climate data, stakeholders in the agriculture sector also have a need for updated market information such as local prices, demand and forecasted yields of various agricultural commodities. The availability of supporting information across the agricultural value chain is needed to assist all participating stakeholders to identify risks and opportunities related to marketing of agricultural produce, for example by guiding a farmer as to where and when to sell surplus produce to maximise returns. Consequently, the accuracy of time-dependent information such as weather forecasts and market updates is as important a consideration as the timeousness of information delivery, where remote rural stakeholders are dependent on realtime updates that supports decision-making before information becomes outdated or inaccurate.

Examples of information and knowledge products identified are detailed further in Chapter 5.1–5.3, below.

5.1 Training manuals and field guides for Conservation Agriculture farmers and extension workers

The information and knowledge products identified in Table 7, below, are primarily field manuals, training guides and planning documents to support the practical implementation of CA and other climate-smart agriculture approaches. The majority of these products were generated through the project-based activities of international development organisations such as FAO and CARE, the World Bank-funded PROMEC initiative and the smallholder's Farmer's Union UNAC. The target audience of these products primarily comprises farmers, farmer's unions and clubs (e.g. informal farmers clubs, UNAC as well as cooperatives such as outgrower schemes), extension workers and other stakeholders participating in the active design or implementation of CA approaches (e.g. workers from NGOs and aid/development organisations). All products identified are published in Portuguese, in addition to which some have also been republished in English. Where available, web links to external copies of these knowledge products are

provided. The relative strengths and weaknesses of the information/knowledge products described are discussed further below (particularly in terms of: i) availability and accessibility; and ii) relevance and applicability).

Table 7 Training manuals and field guides developed for CA approaches in Mozambique

Name of knowledge product	Brief description	Target audience[3]
Manual de AC para técnicos e agricultores (Calegari and Taimo, 2007, PROMEC initiative)	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. Includes: i) general definitions of CA and benefits of CA approaches; ii) detailed descriptions of appropriate crop-specific practices and planting combinations (including growing season length, yield potential, seasonality, tolerance and vulnerability to various stresses such as climate- and pest-related stresses; iii) detailed information on potential cover crops and planting combinations; iv) detailed information on control of pests and diseases; and v) options for upscaling. This technical manual is primarily targeted at Manica, Sofala and Inhambane provinces, and is intended for individuals who are likely to propose, design or manage the implementation of initiatives that will promote/ demonstrate CA. *Available in Portuguese*[4]	farmers; farmer's unions/clubs; public extension workers; project implementing agencies
Guião de facilitador abordagem de Escola na Machamba (EM) Agricultura de Conservação (AC) Regenerativa (Kamp, 2011, CARE Initiative). English title: Farmer Field School Curriculum for Conservation Agriculture	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. *Available in Portuguese and English*[5]	Public extension workers; project implementing agencies
Guião Para Facilitadores. Manual de Facilitação de Práticas Agrárias e de Habilidades para a Vida. FAO, undated English title: Junior Farmer Field and Life Schools Inventory.	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. *Available in Portuguese and English*[6]	Public extension workers; project implementing agencies
Manual de Agricultura Sustentável (Nhancale and Chilaule, 2010, UNAC initiative)	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. *Available in Portuguese*[7]	UNAC (National Peasant's Union); farmer's unions/ clubs; public extension workers)

3 E.g. Farmers, farmer's unions/clubs, public extension workers, researchers, policy-makers, project implementing agencies.

4 http://siteresources.worldbank.org/INTDEVIMPEVAINI/Resources/Manual_AC_FINAL.pdf

5 http://www.iiam.gov.mz/documentos/isfm/AC_Manual_EM.pdf; http://www.iiam.gov.mz/documentos/isfm/CA_FFS_Nampula.pdf

6 http://coin.fao.org/coin-static/cms/media/7/13449340829800/guio_de_facilitadores_final.pdf; ftp://ftp.fao.org/docrep/fao/011/i0379e/i0379e.pdf

7 http://www.iiam.gov.mz/mambots/editors/fckeditor/editor/documentos/isfm/MANUAL_AGRICULTURA%20SUSTENTAVEL.pdf; also available on https://hbjunior19.files.wordpress.com/2016/01/manual_agricultura-sustentavel.pdf

Relevance and applicability

The knowledge products described above collectively provide a substantial and broad platform for transfer of knowledge, skills and understanding on CA and CSA approaches. The information contained can potentially be applicable to a wide range of stakeholders participating in the identification, design and implementation of new CA/CSA approaches in Mozambique. In addition, the material provided includes extensive detail on potential approaches for public demonstration of CA combined with capacity-building and 'training of trainers' activities that is required to support a voluntary and spontaneous upscaling of CA approaches by farmers. The technical content of the manuals ranges from simple, diagram-based guidance and step-by-step instructions that are suitable for audiences with basic literacy and minimal education, up to technically detailed planting guides that include relatively complex guidance that is mainly suitable for advanced consultants, researchers and agricultural project managers. In addition, the technical and geographic scope of the products identified ranges from technically complex and prescriptive approaches that are tailored to specific approaches and agro-ecological zones (such as the "*Manual de AC para técnicos e agricultores*" developed by PROMEC), to broadly applicable manuals which describe a general approach that can be flexibly adapted to different social and agricultural contexts (such as the UNAC "*Manual de Agricultura Sustentável*" manual and the FFS training curriculum "*Guião de facilitador abordagem de Escola na Machamba (EM) Agricultura de Conservação (AC) Regenerativa*" developed by CARE).

As described in the review of past projects and gap analyses undertaken in Part II of this Technical Report (particularly Chapter 3), efforts to promote the upscaled adoption of CA across Mozambique should be based on approaches which are flexible to local context and which includes farmers in the development of locally-appropriate CA approaches. Furthermore, the socio-economic, cultural and agro-ecological variability of Mozambique limits the applicability and effectiveness of prescriptive approaches between and within different farmers, areas and crop types. It is noted that the practices and strategies described in several of the documents are considered to be context- and region-specific and may not be accurate or applicable in other unproven contexts. The PROMEC manual was developed for the specific contexts of Manica, Sofala and Inhambane provinces and as a result the techniques and approaches prescribed require field-testing and possible refinements to be applicable in other areas. The extensive level of detail provided in documents such as the PROMEC manual, which includes recommended planting arrangements, crop combinations, pest control strategies etc. may be too technically complex for the average farmer but can be used as a basis for training of extension workers, establishment of field trials and demonstration plots, and provide innovative insights that can be applied to diverse agro-ecological contexts.

The approach followed in the FFS manual developed by the CARE initiative is partly reliant on the direct participation of farmers in the design and implementation of new adaptive and locally-appropriate agricultural practices. Likewise, the approach adopted by the UNAC manual on 'Sustainable Agriculture' is broadly adaptable to different agricultural contexts and aims to support an improved and practical understanding of sustainable agriculture principles, thereby allowing users to adopt the general principles to be applied to diverse contexts. This is in line with the principle of encouraging the active participation of capacitated farmers in the selection, design and implementation of appropriate approaches/techniques, thereby supporting sustained ownership of activities by farmers.

Availability and accessibility

As described above, the knowledge products described above encompass 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. Identified stakeholders that are targeted by the range of information/knowledge products identified include *inter alia* farmers; farmer's unions/clubs; public extension workers; project implementing agencies. However, a primary challenge to the uptake and adoption of the abovementioned knowledge and information is that, despite the in-depth research and excellent level of detail provided in the identified knowledge products, there are multiple barriers which limit the uptake, application and general level of awareness of these products at a national level. In effect, the majority of products are freely available via the internet to well-resourced stakeholders with access to internet, but generally are not distributed or widely available in hard copy documents (e.g. through farmer's unions, district- or provincial-level extension offices). Furthermore, the available products are generally too extensive and not available in brief or condensed formats to be delivered in alternate media such as mobile-phone based SMS or smartphone applications.

A notable barrier to efforts to communicate general public messages on topics such as climate change adaptation, or more specific messages such as the promotion of CA approaches, is the wide diversity of Mozambique's spoken languages, as well as the wide variability in literacy and access to education across the country's regions. In consequence, the publication of a wide range of information and knowledge products in Portuguese – the national language primary *lingua franca* – provides a useful platform for the transfer of knowledge and technical capacity to literate and well-educated targets, such as researchers and extension officers, but is largely inaccessible to farmers who cannot read or speak Portuguese. This effect is likely to result in negative biases towards provinces, districts and those individual farmers with comparatively lower rates of literacy, education, and standards of living.

5.2 General extension advice and public information to support farmers

The information products described in Table 8, below, are examples of bulletins and summary updates relating to period-specific information such as updated market prices for various commodities, agricultural seasonal forecasts, and short-term weather forecasts. The products identified and described are available through digital media (e.g. online for free download in the case of the 'SIMA' website, or through mobile phone-based platforms in the case of 'E-E-Extension' *aka* '*3-2-1#'). The information products identified have been generated through initiatives led by various international and government agencies and in all described cases are ongoing and updated periodically. All products identified are publicly available in Portuguese. The relative strengths and weaknesses of the information/knowledge products described are discussed in further detail below.

Table 8 Knowledge and information products to support public information and extension services

Name of knowledge product	Brief description	Target audience
SIMA (Sistema De Informação De Mercados Agrícolas De Moçambique)	The SIMA system was established with the support of Michigan State University and USAID, and is hosted on the MASA website (http://www.masa.gov.mz/sima/). The main function of the SIMA system is to provide regular (~weekly/bi-monthly) bulletins to assist farmers in marketing various agricultural products, primarily by providing updated summaries of market prices for various commodities, information on local and regional value chains (such as which areas are marketing surplus produce to other areas with high demand). The SIMA updates include downscaled region-specific information for multiple staple crops. Despite the rich level of detail and regular updates to the SIMA system, the internet-based platform is not well-known and appears not to be widely used by smallholder farmers. A challenge that limits the uptake and use of information in the SIMA updates is that the use of an internet-based platform, the publication of information in Portuguese, and the format of downloadable .pdf summaries is incompatible with the low levels of literacy, internet access and technical capacity of smallholder farmers (the intended target audience of SIMA). *Available in Portuguese*[8]	Farmers, farmer's unions/clubs, public extension workers. To a lesser degree, information can be used by researchers, policy-makers, project implementing agencies
E-E Extension (CLUSA and Vodacom) also known as NCBA CLUSA (* 321 #)	E-E Extension (also popularly known as "três dois um") is a mobile phone-based platform for sharing extension advice via SMS (accessed by dialling '*321#'). The service provides information on land preparation, planting dates, plant spacing, harvesting and marketing of multiple staple subsistence crops. In addition, the platform can be adapted to provide additional information related to health, sanitation, water and climate forecasts. *Available in Portuguese*[9]	UNAC (National Peasant's Union); farmer's unions/ clubs; public extension workers)
INAM Seasonal Forecasts	INAM releases seasonal forecasts for each province at the start of the agricultural season, which is primarily focused on informing farmers of optimal planting times, recommended crop combinations and estimating total seasonal rainfall and resultant yield potential. The effectiveness and accuracy of forecasts is sometimes challenging, largely as a result of the inadequate coverage of Mozambique's hydrometeorological network as well as the unpredictable localised effects of climate change. *Available in Portuguese*	UNAC (National Peasant's Union); farmer's unions/ clubs; public extension workers)

Availability and accessibility

The information and knowledge products described above provide several illustrations of the challenges relating to packaging and communication of updated weather, climate, agronomic and market information for rural stakeholders in remote settings with limited access to media. The information included in products such as the SIMA *Quente-Quente* updates (which provides periodic updates of regional market dynamics and prices of important agricultural commodities) is detailed, downscaled and potentially useful to a wide range of stakeholders across the agricultural value chain. However, the use of an internet-based platform[10] with downloadable .pdf documents as the primary mechanism for communicating information[11] is likely to have the unintended effect of excluding the majority of rural smallholders

8 MASA.gov.mza/sima example Quente quente bulletins such as http://www.masa.gov.mz/sima/quente/QQ1132.pdf

9 Available on mobile phone platforms (*321#)

10 MASA.gov.mza/sima

11 http://www.masa.gov.mz/sima/quente/QQ1132.pdf

who cannot access or interpret the information available. Alternatively, while the E-E-Extension mobile phone platform provides suitably detailed and high-quality information (including market prices, climate & weather forecasts and general extension advice) in an appropriately accessible and cost-effective format for farmers, however the level of public awareness and adoption of the EE mobile extension system remains low and as a result the potential benefits of information are not realised by the majority of farmers.

The distribution and communication of the INAM seasonal forecasts is challenged by multiple technical, logistic and institutional barriers. In terms of the primary barriers to communication of seasonal forecasts to extension officers and farmers, INAM does not have adequate geographic representation of staff to deliver public presentations of the seasonal forecasts, and as a result only a small number of individuals are able to attend the presentations held in each of the provincial capitals. The challenge of presenting the seasonal forecasts in multiple geographic locations is compounded by the urgent need to deliver the forecasts timeously, so that stakeholders such as farmers have adequate time to respond (e.g. in terms of selection of crops, timing of land preparation and planting).

Relevance and applicability

The E-E-Extension system is a highly applicable and relevant tool which is in an appropriate format to be accessed by a large network of rural farmers who would otherwise be disconnected from media formats such as internet, radio, and television. In addition, the system has the potential to increase access to extension advice in remote districts where extension officers may be unavailable. Additional research is needed to vigorously assess the satisfaction of users with the range of information services provided, however the themes addressed include a considerable range of agricultural, meteorological, marketing and health topics in a user-friendly and cost-effective format.

The system adopted in the SIMA *Quente Quente* updates unfortunately may have the effect of reducing the applicability and relevance of the information to farmers targeted by the updates. The information contained, such as updated prices for important crops and commodities, is of a good quality and responds directly to the information needs of farmers who are disconnected from markets and are exposed to potential financial risks in the absence of clear information to inform their marketing decisions. However, as discussed with respect to considerations of 'Availability' (above) the potentially useful information contained in the *Quente Quente* updates is only accessible through internet-based downloads of .pdf files, thereby limiting access to those users who are able to view documents on a computer or in printed hard copy. In consequence, many potential users do not have the opportunity to assess the applicability of the SIMA system when purchasing or marketing agricultural commodities.

In contrast to the other two examples discussed here, the relevance and applicability of the INAM seasonal forecasts is questionable from the perspective of most farmers. The presentation of the seasonal agricultural forecasts at regional population centres is of some limited applicability to agricultural extension officers who are in the proximity of, or can obtain transport to attend, the forecast presentations. However, the forecasts are not formatted for broadcast on oral mediums such as television and radio, nor are the main findings or implications circulated in hard copy format to district centres, farmers unions and extension officers. As a result of the limited budget allocation to Mozambique's meteorological services, the INAM website is not currently operational and cannot be used to access updated short-term or seasonal forecasts. Finally, in terms of the applicability and relevance of the information contained in seasonal forecasts to the majority of farmers, the content of the forecasts is too technically complex and presented without sufficient consideration of the practical implications to most farmers.

Accuracy and timeousness

In the case of time-bound information such as weather forecasts, market updates and extension advice, the accuracy and reliability of information is strongly dependent on a timeous delivery to the user. Consequently, the choice of format and media for communication has a strong influence on the timely delivery of information and the resulting accuracy and suitability for purpose. Consequently, the publication of dynamic data (such as SIMA's market prices or INAM weather forecasts) in static formats (such as .pdf format or other written document) has the unintended effect of undermining the quality and accuracy of information availability to the end user. Alternatively, the use of dynamic platforms such as E-E-Extension's mobile phone format provides a mechanism for regular or real-time updates that gives users access to the most updated information possible. In the case of the INAM seasonal forecasts, the use of a public forum to present forecasts creates a logistic barrier that prevents simultaneous transfer of information to all geographic areas. As a result, there is potential for the forecasts to be delivered too late for farmers to act on the information delivered (e.g. to begin preparation of lands before arrival of rains).

The challenge of timeous delivery of the abovementioned information products is further compounded by the factors which limit the degree of technical accuracy and detail that can be delivered. In the case of the INAM forecasts, the most prominent barrier (which is largely beyond the technical scope of this study) is the limited extent of Mozambique's hydrometeorological monitoring. The spatial coverage and density of INAM's monitoring network and historical climate records is inadequate to provide accurate, downscaled forecasts across Mozambique's highly variable landscape and agro-ecological zones. In consequence, the coarse resolution and inconsistent coverage of INAM's observational data may undermine the accuracy of INAM's daily and seasonal forecasts. The well-intentioned delivery of inaccurate forecasts may have the potential to increase the vulnerability of farmers or encourage maladaptive practices, by inadvertently suggesting inappropriate crop choices or planting strategies for the coming agricultural season. In the long term, the cumulative effect of inaccurate or delayed forecasts may result in farmers losing faith or developing a sense of suspicion of public extension services and other general forms of public service and information. Therefore, the barriers that hinder the development of INAM and supporting institutions must continue to be the focus of sustained investment and capacity-development as a matter of urgency in order to support farmers as well as extension services with accurate and downscaled climate information.

5.3 Surveys, monitoring and evaluation of adoption of practices such as Conservation Agriculture

An important information need that has been identified by this study as well as previous researchers is the need for systematic surveying and other forms of monitoring to assess the general rate of understanding, acceptance and adoption of adaptation practices such as CA across Mozambique. In addition, there is a general need for systematic collection and reporting of information on farmer decision-making, risks and opportunities in each administrative region. The increased availability of the latter kind of information and knowledge products will support policy-makers and researchers to assess the scale of adoption of various agricultural and/or adaptation technologies and identify successful approaches to be replicated. The main product that was identified was the annual National Agricultural Survey (*Trabalho de Inquerito Agricola*, TIA). The TIA is summarised in Table 9, and is discussed and assessed in further detail below.

Table 9 Knowledge and information products based on surveys and monitoring of agricultural practices

Name of knowledge product	Brief description	Target audience
TIA (Trabalho de Inquerito Agricola) English: National Agricultural Survey	MASA, and formerly MINAG, have undertaken national agricultural surveys since at least 1996. The TIA survey has been undertaken annually since ~2002 and has resulted in the accumulation of a large amount of data including inter alia household-level crop choices, yields, cultivation methods, use of inputs, access to extension services, credit, livestock and demographics of farming households. Since 2012, a revised survey known as the Inquerito Agricola Integrado (IAI) has been undertaken. The datasets generated by the TIA surveys allow historical comparisons between and within provinces and agro-ecological zones, and have the potential to address the lack of systematic statistical data on Mozambique's agriculture sector and rural households. Furthermore, the mechanism and experience established by the TIAs provide an excellent platform for collection of additional categories of information relating to agricultural risks, climate vulnerabilities and decision-making by farmers. Summarised data is available from the Michigan State University, which collaborated with MASA in the analysis of survey data. Available in Portuguese, summaries available in English[12]	Researchers, Policymakers

The summarised findings of several past TIA surveys are freely available via the Michigan State University's Food Security Group portal[13] in English and Portuguese, however the underlying data is owned by MASA and must be accessed by request.

In terms of the relevance and the applicability of the survey data, the TIA represents a mechanism for systematic collection of repeated data on the socio-economic, biophysical and economic impacts of climate change on farming/rural households, as well as the approaches and responses adopted by farmers. These kinds of data and information can be used to monitor progress of, and identify successful strategies to support, the implementation of sectoral and cross-sectoral strategies on climate change and agricultural development. However, at present there appears to be a low rate of awareness or use of the findings of TIA surveys outside of specific MASA directorates. The adoption of useful TIA findings may potentially be increased or supported through development of tailored policy briefs which present highlights for specific stakeholders (e.g. tailored for groups such as GIIMC).

12 http://fsg.afre.msu.edu/mozambique/survey/

13 http://fsg.afre.msu.edu/mozambique/survey/

PART IV

Key Findings and Recommendations

6 Synthesis

Parts I–III of the Technical Report, above, respectively address the themes of: i) Institutional Framework and Policies on climate change, with an emphasis on Conservation Agriculture as an adaptation theme; ii) Conservation Agriculture in Mozambique, including past projects and lessons learned; and iii) Information and Knowledge Products to information initiatives focused on adaptation in the agriculture sector, with an emphasis on Conservation Agriculture. The summarised findings within each of these components of the Technical Report can be assessed collectively to contribute towards the main research questions of this study: "*What is the current state of adaptation knowledge in Mozambique and how can it be enhanced to enable more effective climate adaptation responses that work and increase resilience for the most vulnerable*?"

In consideration of the well-established vulnerability of Mozambique's largely agrarian rural population to climate change, the approach of this study has been to assess the state of adaptation knowledge (and resultant implications for policy and practice) with an emphasis on the agriculture sector and the application of Conservation Agriculture approaches as part of Mozambique's adaptation response. However, many of the findings and recommendations can be applied more generally across broader themes of climate change adaptation, socio-economic development and engagement of the smallholder farming sector in Mozambique.

In view of the ongoing and future climate change and in order to grow with resilience in the agriculture sector, the findings and recommendations in this report are aimed for the Government of Mozambique, working with private sectors, stakeholders, NGOs and Civil Society Organizations.

The main summary findings and resulting recommendations and needs are described according to the structure proposed in the development of the original research question (described in detail in supporting Appendix X). Specifically, this summary chapter discusses the state of adaptation knowledge from the perspectives of: i) institutional and policy framework, coordination and decision-making at a central level; ii) academic research and development, information and knowledge management; and iii) field-level implementation and practice.

6.1 Institutional and policy framework, coordination and decision-making at a central level

6.1.1 Enabling environment and coordination findings

In general, the sectoral and cross-sectoral priorities and institutional arrangements on climate change are clear and well-aligned: from the national-level 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 CSA into local-level land planning. The technical capacity, mechanisms and lessons learned by the initiatives reviewed in this study provide a solid foundation for the implementation of Mozambique's strategic objectives on climate change in general and adaptation through CA in particular. However, further statutory revisions are recommended to increase the efficiency and coordination between stakeholders. This study identified multiple factors which contribute to the likelihood of sustained adoption of CA by vulnerable farmers

and provided resultant recommendations to support the implementation of national priorities on climate change and agriculture (described in full in Chapter 4.8). Research findings support the rationale for MASA's proposed approach to upscaling of CA approaches across Mozambique, which is based on expansion of the DNEA extension network and FFS training facilities. Therefore, recommendations generated by this study include *inter alia*:

Recommendations

At a central level:

a) One of the most important gaps to be addressed in institutional coordination is the need to formalise the mandate of GIIMC and enable the effective functioning of the national Climate Change Network.

- The formalisation of GIIMC as an entity mandated with coordination and information-sharing will reduce the risk of overlapping mandates and duplication of activities between national-level stakeholders such as INGC and MASA.

b) With respect to the needs of cross-sectoral institutions and entities focused on climate change, the study identified **several national institutions which require signification additional budgetary, technical and political support.**

- **The National Sustainable Development Fund (FNDS) requires considerable support to provide a potential source of domestic funds for publicly-financed initiatives on climate change**, sustainable resource use and other related themes.
- There is an urgent need to **secure funds through public budget allocation or additional multilateral support to sustain the operation and upscaling of the Knowledge Management Centre (CGCMC)**, which is intended to address the need for a centralised resource for knowledge, information and research on climate change in Mozambique.
- There are multiple technical, logistic and institutional **barriers that undermine the effectiveness of the National Institute of Meteorology (INAM) which must urgently be addressed through sustained investment and capacity-development** in order to support farmers as well as extension services with accurate and downscaled climate information.

At the sectoral level of priority actions within MASA's portfolio:

c) Sustained budgetary and political support is needed to ensure the implementation of the priority actions identified in the Action Plan for Climate Smart Agriculture.

- The implementation of MASA's priorities for climate change adaptation in the agriculture sector, which emphasises demonstration and promotion of CA approaches, will be reliant on the expansion of the national extension network and increased coverage of Farmer Field School facilities.

d) There is a need to further strengthen and formalise the mechanisms for national level coordination between researchers and extension services:

- These include *inter alia* stakeholders such as the Mozambique Platform for Agricultural Research and Technological Innovation (PIAIT), Directorate for Training, Documentation and Technology Transfer (DFDTT), members of the Conservation Agriculture Working Group (CAWG) and diverse NGOs and implementation partners at the field level.

e) At the level of national/centralised decision-making, one of the priorities identified is the need to develop the value chains and supporting market linkages for agricultural inputs such as fertilisers, herbicide and hybrid seed.

- These measures should include the implementation of targeted programmes to specifically increase access to inputs by smallholders.

f) Measures to increase the linkage of smallholder farmers with agricultural value chains will require simultaneous efforts to increase farmer access to credit and financial/banking services.

g) Sustained political support, budgetary allocation and technical assistance from international partners should be directed to the expansion of these successful approaches.

h) It is recommended that **future updates to the strategies and policy instruments which guide the agriculture sector should investigate opportunities and synergies between promotion of livestock husbandry and upscaling of the Conservation Agriculture approach using animal draught power.**

6.1.2 Research and information needs findings

Recommendations

a) At the level of centralised decision-making, **the priority information gaps which should be addressed by further research relate to farmer decision-making, incentives and rates of adoption of CA** (presented in detail in Part II).
- In the absence of this information, policy-makers are unable to assess the effectiveness and sustainability of past investments in promoting CA and related approaches.

b) **Mechanisms such as the TIA should be adapted to collect relevant information and feed into SNMAMC M&E framework** (discussed below).

c) It is recommended that **future initiatives which aim to promote or demonstrate CA approaches include budgeted measures for long-term (>5 years) assessment of household income and wellbeing relative to a baseline.**

6.1.3 Information products and knowledge management findings

At a cross-cutting level, the ENAMMC notes that "research and systematic observation" of climate change is ineffective as a result of the limited availability of data measurements taken at "appropriate frequency and scale". This represents a significant barrier to determining the real impacts of climate change. Further, ENAMMC notes that the lack of inter-sectoral engagement in the systematic collection of climate data, the lack of standardization, irregularity and low quality of climate data are all barriers to effective research and observation of climate change impacts. The datasets generated by the TIA surveys have the potential to address the lack of systematic statistical data on Mozambique's agriculture sector and rural households, however at present there appears to be a low rate of awareness or use of the findings of TIA surveys outside of specific MASA directorates.

Therefore, recommendations generated by this study include *inter alia:*

Recommendations

a) **Systematic monitoring of local-level vulnerabilities, wellbeing, and rates of adoption of adaptation practices such as CA must be urgently prioritised at the district and provincial levels**, to monitor progress towards cross-cutting climate change objectives as well as sectoral objectives within MASA's mandate.

b) The adoption of useful **TIA findings should be supported through development of tailored policy briefs which present highlights for specific stakeholders** (e.g. tailored for groups such as GIIMC).

c) Several institutions require considerable **technical and financial support to enable a strong role in the generation and management of knowledge/information** and which will require sustained support and long-term plans for sustainability, including *inter alia*:
- **INAM** (which plays an important but underdeveloped role in the generation of climate and weather information);
- **Knowledge Management Centre in Climate Change (CGCMC**, the strengthening of which was proposed by the ENAMMC), and;
- **Agricultural Research Institute of Mozambique (IIAM**, an important contributor to research and knowledge).

6.2 Academic research and development, information and knowledge management

6.2.1 Enabling environment and coordination findings

As outlined above in 6.1 and elsewhere in this technical report:

Recommendations

a) the successful delivery of Mozambique's objectives for climate change adaptation will require **strengthened systems and institutions for continuous research and information-gathering**. These include:
- **existing information needs and gaps** (such as those discussed in Part II, Chapter 4, of this report),
- **emerging needs for Monitoring & Evaluation of the various programmes and actions that are proposed at cross-cutting and sectoral levels.**

b) Wherever possible, the **existing mechanisms for coordination between stakeholders working on related themes should be strengthened and utilised** to share emerging research priorities, results, and synergies/ opportunities for collaboration.

6.2.2 Research needs findings

The apparent benefits of different CA approaches are widely variable across Mozambique's diverse rainfall regimes and soil types. In addition, as described in Part II, a widespread challenge to harmonisation and coordination of activities related to promotion and research of CA is the variety of definitions and practices promoted by different organisations. At the field-level, there remain significant biophysical research gaps which should be considered in the design, monitoring and evaluation of newly-established initiatives. In consequence, recommendations of this study include *inter alia*:

Recommendations

a) **Locally appropriate CA approaches need to be identified and adapted to local context as part of the innovation process facilitated by participatory research.**

b) **Future research undertaken on CA should include consideration of** the relative importance and effectiveness of:
- **soil conservation and minimum tillage principles** as part of the assumed definition of CA; and
- **high-input vs. low-input approaches to CA**, within the local context.

At a national level:

c) **Limited knowledge on the decision-making, incentives and rates of adoption of CA by farmers must be addressed in the formulation of new research projects and initiatives.**

d) **Annual TIA surveys provide a mechanism for systematic collection of repeated data which should be enabled to support increased information** on the socio-economic, biophysical and economic impacts of climate change on farming/rural households, as well as the approaches and responses adopted by farmers.

At the field level:

e) **Biophysical information gaps that field practitioners and researchers must address include** *inter alia*:
- **appropriate tillage and soil management strategies**;
- **suitable cover-crop combinations** for different agro-ecological zones;
- **appropriate nitrogen-fixing species** to improve soil fertility; and
- **identification of CA systems that are compatible with livestock production** (discussed further in 6.3, below).

6.2.3 Information products and knowledge management findings

As a result of the wide diversity of spoken languages and variability in literacy and access to education, there are considerable inequalities between provinces, districts and individuals in access to existing knowledge, information and technical support. As a result, the vulnerability of those households and communities with the lowest rates of education and standards of living is exacerbated by the limited access to information. The choice of format and media for communication has a strong influence on the timely delivery of information and the resulting accuracy and suitability for purpose. Therefore, this study recommends:

Recommendations

a) **Methods and media for communication and awareness-raising of climate change-related information, including adaptation technologies such as CA, should be selected with clear consideration of the intended target audience.**

b) **Mobile phone-based tools such as the E-E-Extension system should be further explored as an approach to delivering information to rural farmers** who would otherwise be disconnected from media.
   - In contrast, mechanisms such as the SIMA *Quente* updates provide useful information of a good quality but using an inappropriate format which is likely to be inaccessible to most farmers.

c) **Additional research is needed to vigorously assess the satisfaction of users with the range of information services provided by E-E-Extension and other mobile phone-based platforms.**

6.3 Field-level implementation and practice for the agriculture sector

6.3.1 Enabling environment and coordination findings

This study identified multiple factors which contribute to the likelihood of sustained adoption of CA by vulnerable farmers and provided resultant recommendations based on these findings (described in full in Chapter 4.8). One of the clearest messages that emerged from review of all past research was that the development of participatory, locally-adapted, farmer-selected 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.

In terms of the implications for field-level practitioners of CA, including project managers, extension workers and researchers, some key findings related to understanding the factors and incentives that influence farmer decision-making. Research summarised in Part II of this Technical Report found that most farmers are unable to wait for the long-term benefits of CA to be realised as a result of the immediate socio-economic challenge and poverty that tends to influence decision-making 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, this study recommends:

Recommendations

a) **All future initiatives are encouraged to adopt participatory approaches that include farmers, extension agents and researchers in a collaborative effort** to identify locally appropriate practices and make use of local knowledge and expertise.
b) Efforts to transfer new technologies or skills to farmers should **prioritise the participation of farmers and communities that belong to cooperatives and farmer's clubs to encourage a 'horizontal' transfer of knowledge and experience within existing farmers' networks.**
c) **Future initiatives which aim to promote the long-term benefits of CA approaches should identify practices that generate tangible near-term benefits to incentivize continuation of CA approaches**
   - This may include opportunities to generate additional income through cultivation of cash crops, improved food security and nutrition through diversification of staple crops.

6.3.2 Agricultural Research needs findings

In terms of agronomic and biophysical research gaps at the field level, the priority information gaps to be addressed by further research mainly relate to testing the performance of specific CA approaches in each agro-ecological region (detailed fully in Part II of the Technical Report). In addition, as previously described the evidence base for CA and related approaches will benefit from efforts to quantify the socio-economic benefits to households which adopt CA. Examples of past initiatives discussed in this study have noted that farmers can potentially play an active or even leading role in field research on CA and related approaches and addressing the information gaps identified.

Consequently, some of the recommendations for research priorities that were generated by this study include *inter alia*:

Recommendations

a) **Basic agronomic studies to identify optimal strategies for tillage, planting combinations and crop rotations, and use of inputs** appropriate to the local context and farmer preferences;
b) **Future initiatives which aim to promote or demonstrate CA approaches should include budgeted activities for long-term (>5 years) assessment of agronomic performance, soil fertility and household wellbeing** relative to a baseline.
c) **Participatory research initiatives should prioritise equitable and collaborative approaches which includes farmers in the design and execution of** research experiments.
d) **Prioritise the identification of opportunities such as censuses and surveys to collect agronomic and socio-economic information** to inform the SNMAMC M&E framework.
e) **Initiatives which aim to promote or demonstrate CA approaches include budgeted measures to undertake long-term (>5 years) research and assessment of household income and wellbeing** (including establishment of a baseline).

6.3.3 Information products and knowledge management

As a result of the efforts of a number of past initiatives implemented by government-, NGO- and international development organisations, there are multiple existing knowledge and information products available to support future initiatives and projects. These include *inter alia* field manuals, training guides and planning documents to support the practical implementation of CA and other climate-smart agriculture approaches. The target audience of these products primarily comprises farmers, farmer's unions and clubs (e.g. informal farmers clubs, UNAC as well as cooperatives such as outgrower schemes), extension workers

and other stakeholders participating in the active design or implementation of CA approaches (e.g. workers from NGOs and aid/development organisations). Knowledge products available to project practitioners, extension officers and trainers 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. One of the primary challenges to the uptake and adoption of the abovementioned, and other, knowledge and information products is that the majority of the intended target audience do not have access to existing products via the internet, and hard copy documents are not widely distributed beyond regional centres.

In addition, the extensive level of technical detail provided in documents such as the PROMEC manual, which includes recommended planting arrangements, crop combinations, pest control strategies etc. may be too technically complex for the average farmer but can be used as a basis for training of extension workers, establishment of field trials and demonstration plots, and provide innovative insights that can be applied to diverse agro-ecological contexts. Other existing knowledge products are based on relatively flexible, non-prescriptive and broadly applicable manuals which describe a general approach that can be adapted to different social and agricultural contexts (such as the UNAC "*Manual de Agricultura Sustentável*" manual and the FFS training curriculum "*Guião de facilitador abordagem de Escola na Machamba (EM) Agricultura de Conservação (AC) Regenerativa*" developed by CARE) (described fully in Part III of this Technical Report). The aforementioned approach is in line with the principle of encouraging the participation of capacitated farmers in the selection, design and implementation of appropriate approaches/techniques, thereby supporting sustained ownership of activities by farmers.

Consequently, the recommendations generated by this study include *inter alia*:

Recommendations
a) Wherever possible, **information and knowledge products aimed at transferring CA approaches to smallholder farmers should prioritise the use of flexible, non-prescriptive and broadly applicable approaches that can be adapted to different social and agricultural contexts.**
b) Future **initiatives which aim to develop tailored information or knowledge products aimed at smallholder farmers and rural households should include consideration of the literacy, spoken language and access to media of the target audience.**

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