Evidence and policy implications of Climate-Smart Agriculture in Kenya

Working Paper No. 90

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Managing Editors: Sabrina Chesterman & Constance Neely

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Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

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Abstract

This technical paper details findings and outcomes from the workshop hosted by the Climate Change Unit of Ministry of Agriculture, Livestock and Fisheries of Kenya, along with the FAO, ICRAF and CCAFS. The process engaged stakeholders from research, practice and policy and to interactively share and analyze scientific evidence and field experience from over 40 projects related to climate-smart agriculture (CSA) within integrated farming systems in Kenya. A current state of knowledge on how CSA serves to simultaneously achieve Kenya's development goals and climate change targets and relevant policy linkages is presented. Overarching recommendations for outscaling CSA in Kenya consider that: integration is required at all different levels; access to productive inputs and markets is essential; knowledge generation and sharing are critical for evidence based decision making; inclusiveness and contextualisation promote ownership and uptake; and the importance of building synergy and addressing potential inconsistencies between policies, regulations and implementation. Lastly, evidence-based and jointly agreed upon messaging regarding CSA is presented, as a contribution to the policy dialogues of the UNFCCC (COP 20, December, Peru[1]), Paris 2015 and other international efforts and fora, including the Alliance for CSA in Africa. The key policy recommendations elaborate upon: the consideration of development priorities; connection of interdisciplinary research, practice and policy; integration of farm and landscape systems; inclusion of women and youth; connection of policy and regulations and the filling of identified knowledge gaps.

Keywords

Climate-Smart Agriculture; Development Research; Agricultural Policies; Knowledge Based Systems; Landscape; Farming Systems

Acknowledgements

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CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS World Agroforestry Centre Food and Agriculture Organization of the United Nations

Executive summary

In October 2014, the Climate Change Unit of the Ministry of Agriculture, Livestock and Fisheries of Kenya, along with the FAO, ICRAF and CCAFS, convened a workshop to engage stakeholders from research, practice and policy to interactively share and analyze scientific evidence and field experience from over 40 projects related to climate-smart agriculture (CSA) within integrated farming systems in Kenya. CSA "in the context of national food security and development goals, aims to tackle three main objectives[1]; sustainably increasing food security by increasing agricultural productivity and incomes; building resilience and adapting to climate change as well as developing opportunities for reducing greenhouse gas emissions compared to expected trends[2]".

Through focused sessions and based on the principles of the ICRAF Stakeholder Approach to Risk Informed Evidence Based Decision Making (SHARED) framework, participants took stock of the current state of knowledge and explored the dimensions of CSA application in Kenya. This critical unpacking of CSA allowed for evaluation and discussion across the broad range of actors gathered from farmers, researchers, development practitioners and climate change policy makers and for a coherent articulation of how CSA serves to simultaneously achieve Kenya's development goals and climate change targets. This effort, in combination with integrative analysis of the projects and experiences presented, resulted in the development of joint messaging and policy recommendations for immediate input to the revision of the Draft National Climate Change Policy Framework (2014). Further, the workshop delivered evidence-based and jointly agreed upon messaging regarding CSA, as a contribution to the policy dialogues of the UNFCCC (COP 20, December, Peru[3]), Paris 2015 and other international efforts and fora, including the Alliance for Climate-Smart Agriculture in Africa. This document provides the technical background and policy messaging that resulted from the workshop with 56 experts from 22 different organizations and 2 National Ministries working on Climate-Smart Agriculture across 30 counties in Kenya.

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[1] FAO 2013. Climate-Smart Agriculture Sourcebook

[2] http://www.fao.org/3/a-i4226e.pdf

[3] FAO. 2014. http://www.fao.org/climatechange/42101-052030dc948c02b143ca95a7f96cdc7bb.pdf

Overarching recommendations for outscaling CSA

Integration is needed at different levels and in different dimensions. Scaling out CSA requires moving beyond individual practices to integrate through whole farm and whole landscape systems and approaches. Integrating CSA in whole farm systems and landscapes builds synergies and addresses trade offs among different components to achieving overall desired CSA outcomes. Adaptation and low-emission development should be intentionally linked. CSA interventions are context specific and influenced and impacted by cultural norms. CSA outscaling will not be successful without fully integrating gender dimensions and capacity development from the outset.

Access to productive inputs and well functioning markets are essential. Systems level thinking needs to be applied, including taking into account farm and landscape CSA as well as value chain assessments and actions that enable climate smart development, more equitable transactions and markets to support CSA efforts. Access to financing for appropriate CSA implementation is needed. These financial resources apply to productive inputs (knowledge and technologies) as well as incentives to adapt more integrated approaches.

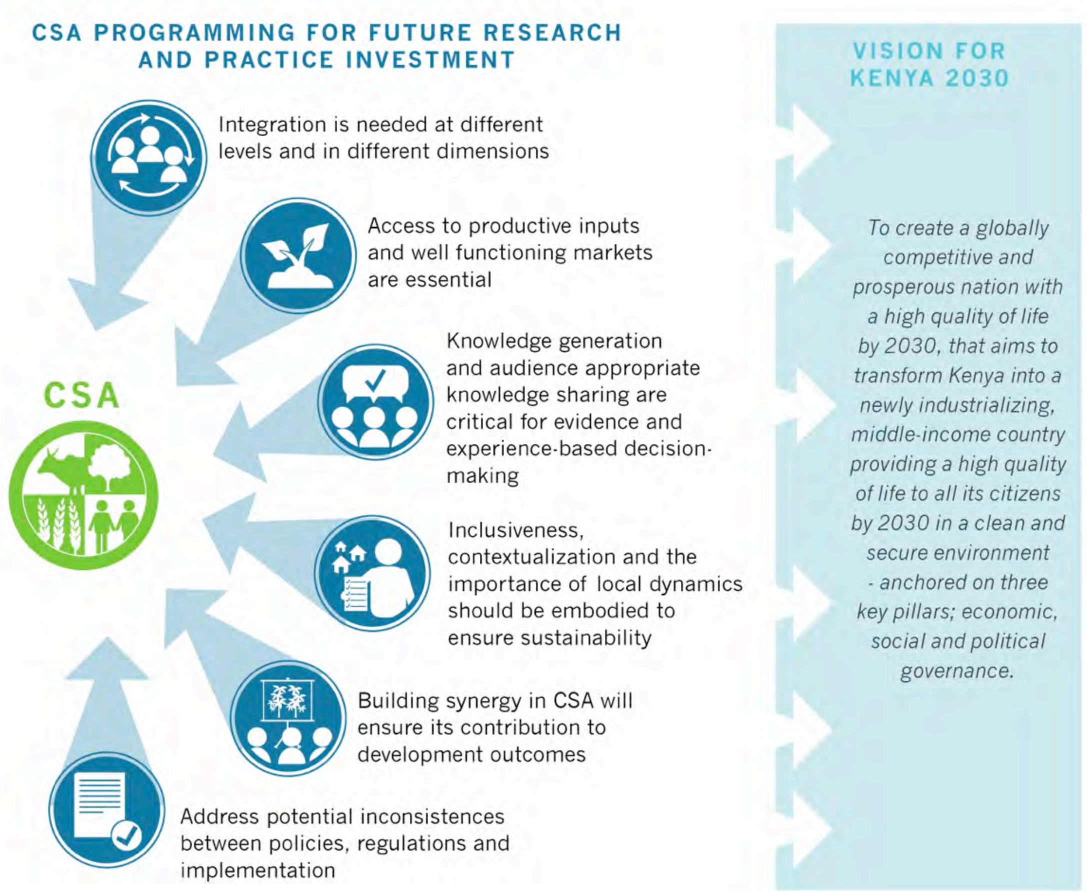
Knowledge generation and sharing are critical for evidence and experience-based decision-making. The urgency of change that is needed means that research, practice and policy must be integrated and that "learning by doing" knowledge is consistently communicated across the various communities of practice. Agriculture, environment and societal dimensions (emphasizing gender as well) can no longer be segregated but, rather, must be fully and intentionally integrated to accelerate learning across disciplines and subsequently achieve synergies and impact.

Inclusiveness, contextualization and the importance of local dynamics should be embodied to ensure sustainability. Climate-smart Agriculture (CSA) is context specific and must be developed within social and cultural norms. Deliberate efforts must be undertaken to ensure better understanding of the socioeconomic and biophysical context and constraints that inform farmers' decision-making. Authentic engagement of women and youth will accelerate CSA impacts. Understanding local dynamics also helps to address another important concern: remaining cognizant of the trade-offs and rising conflicts due to changes occurring because of climate change and during CSA adoption.

Building synergy in CSA will ensure its role in a development context. There is a need to emphasize practices that can simultaneously address resilience/adaptation, mitigation/low emissions development and food and nutrition security, as well as the incentives and capacities to reinforce these practices. In evaluating systems, CSA actions and processes must fit within the larger Kenyan development vision, including enhancing employment, income, nutrition status, education and market opportunities and contributing to overcoming social inequities.

Address potential inconsistencies between policies, regulations and implementation. As greater knowledge becomes available for implementing CSA, analyses of regulatory and policy frameworks need to be undertaken in order to ensure that they support rather than discourage CSA actions and up-scaling.

The overarching recommendations for out-scaling CSA within integrated farming systems in Kenya



Joint policy messaging

The workshop concluded with the establishment of joint policy messaging developed with the CCU of the MALF and the CC Secretariat of the MEWNR as input to the Kenya Climate Change Policy Framework as well as for circulation during the UNFCCC COP-20 in 2014:

Consider development priorities. Climate-smart agriculture (CSA) must contribute to building opportunities for employment, education and market opportunities. CSA is smart precisely because it addresses a range of key development issues.

Connect interdisciplinary research, practice and policy. Research, agricultural activities and policy development should be integrated from the start of any CSA initiative. This improves decision making at all levels because the decisions are based on a broader base of scientific evidence and field experience.

Integrate farm and landscape systems. Integrating the production of livestock, fish, crops and trees on farms or throughout the entire landscape can enhance productivity, strengthen the resilience of farming systems and reduce and remove greenhouse gas emissions.

Include women and youth. Specific attention needs to be paid to building the capacity of women, men and youth who manage natural resources. Farming skills, as well as leadership and facilitation skills can be built with the support of local groups that can tailor climate information to community needs and make available necessary materials.

Connect policy and regulation. Inconsistencies between policies and regulations can undermine CSA.

Fill knowledge gaps. CSA still faces a number of knowledge gaps, including a lack of:

- Baseline data for measuring, reporting and verifying the effectiveness of CSA practices;
- Reliable, downscaled climate and weather forecasts;
- Country-specific emission factors;
- An understanding of the change in the greenhouse gas balance and other impacts brought about by the integration of livestock and/or fish farming, conservation agriculture and planting trees on farms and in the landscape;
- Evidence of mitigation options offered by alternative energy sources;

- Appropriate inputs to advance CSA, evidence of reduced GHG emissions through alternative energy sources in larger value chain analyses;
- Emission factors from livestock and aquaculture in integrated farming systems including livestock and conservation agriculture with trees interactions;
- Incentives for manure management, reliable climate forecasts, greater understanding and implementation of appropriate finances and insurance schemes and raising greater awareness at farmer level.

Contents

Figures and Tables

Acronyms

ABCD	Assets-based community development
ACCI	Adaptation to Climate Change and Insurance Project
ADP	Area development program
ASAL	Arid and semi-arid land
ASDSP	Agricultural Sector Development Support Program of Kenya
CA	Conservation agriculture
CAADP	Comprehensive Africa Agricultural Development Program
CAWT	Conservation Agriculture with Trees
CCAFS	Climate Change, Agriculture and Food Security Program
CCU	Climate change unit
CGIAR	Consultative Group on International Agricultural Research
CH_4	Methane, a greenhouse gas
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CO	Carbon monoxide
CO_2	Carbon dioxide, a greenhouse gas
CREATE	Community Resilience Against Environmental Threats
CSA	Climate-smart agriculture
CSA-RA	Climate-smart agriculture rapid appraisal
CSO	Civil Society Organization
DFBA	Dairy Farmers Business Association

DFID	UK Department for International Development
EAC	East African Community
EADD	East Africa Dairy Development
EIA	Environmental impact assessment
ESAF	East and Southern Africa
ETc	Crop evapotranspiration
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer field schools
FICCF	Finance Innovation for Climate Change Fund
FMNR	Farmer managed natural regeneration
GCF	Green Climate Fund
GDP	Gross domestic product
GHG	Greenhouse gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GIZ/PSDA	Promotion of Private Sector Development in Agriculture
IBLI	Index Based Livestock Insurance
IBWI	Index Based Weather Insurance
ICRAF	World Agroforestry Centre
ICPRC	Integrated Climate Protection and Resource Conservation
ICT	Information communication technology
IDP	Internally displaced person
IGA	Income generating activities
ILRI	International Livestock Research Institute

IITA	International Institute for Tropical Agriculture
ISAK	Improved Stoves Association of Kenya
ISFM	Integrated soil fertility management
KACP	Kenya Agricultural Carbon Project
KALRO	Kenya Agriculture and Livestock Research Organization
KAPP	Kenya Agricultural Productivity Program
KARI	Kenya Agriculture Research Institute
KCCAP	Kenya Climate Change Action Plan
KENAFF	Kenya National Farmers' Federation
KENDIP	Kenya Domestic Biogas Program
KENFAP	Kenya National Federation of Agricultural Producers
LCA	Life cycle assessment
LDSF	Land Degradation Surveillance Framework
LSP	Local strategic partnership
MALF	Ministry of Agriculture, Livestock and Fisheries
MICCA	Mitigation of Climate Change in Agriculture Programme
MLND	Maize Lethal Narcosis Disease
MFI	Micro-finance institution
MRV	Measuring, reporting and verification
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NARDTC	National Aquaculture Research, Development and Training Centre
NCCAP	National Climate Change Action Plan

NCCRS	National Climate Change Response Strategy
NDVI	Normalized Difference Vegetation Index
NEPAD	New Partnership for Agricultural Development
NPBM	National performance and benefit measurement
OM	Organic matter
PRA	Participatory rapid appraisal
REDD+	Reduction of Deforestation and forest Degradation
RINCOD	Revitalization of Indigenous Initiatives for Community Development
RWHT	Rainwater harvesting technology
SACCO	Savings and Credit Co-operative
SALM	Sustainable agriculture and land management
SAPLIP	Samburu Arid Land Support Program
SHARED	Stakeholder Approach to Risk Informed and Evidence Based Decision Making
SLU	Swedish University of Agricultural Sciences
SNV	Netherlands Development Organization
SOC	Soil organic carbon
TASLIP	Turkana Arid Land Support Program
TFAK	Tree Farmers' Association of Kenya
ToT	Training of Trainers
TRAC	Methodology to Track Adaptation
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
VSLA	Village Savings and Loan Associations

WUE	Water Use Efficiency

1. Rationale and objective of the workshop

Decision makers[4] operating at various levels (local, national, regional, international) are seeking ways to address inter-related, complex and often seemingly intractable problems associated with the impacts of climate change. Donors, investors, policy-makers and coordinating bodies aim to ultimately reduce risk and realize positive long-term impacts for their resource investments taking into account climate variability and its projected impacts. Evidence and experience based and risk informed decision-making, whether local, national, regional or global, has become increasingly viewed as important. Informed decision-making is a key intervention entry point for influencing the resilience and productivity of lives, livelihoods and landscapes[5]. There is now an urgent need to tap the collective resources of integrated research, development and policy domains. This is to ensure greater understanding across knowledge systems and actors to guide climate change decision making and on the ground practices toward the desired outcomes of food security, adaptation to climate change and low emissions development within the context of national level goals and development plans.

The paradigm of climate-smart agriculture (CSA) is actively being implemented in Kenya as part of the Kenya Climate Change Action Plan (2013-2017). CSA "in the context of national food security and development goals, to tackle three main objectives[6]; sustainably increasing food security by increasing agricultural productivity and incomes; building resilience and adapting to climate change as well as developing opportunities for reducing greenhouse gas

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[4] Decisions are made by those individuals and groups that manage the natural resource base directly - women and men pastoralists, farmers, fisherfolk and forest dwellers - as well as those who indirectly influence the management of the natural resource base and the livelihoods upon which it depends – such as local institutions and authorities, advisory service representatives and development practitioners, traders and processors, private sector, financiers, researchers, government technicians and policy makers, consumers, media, and donors among many others.

[5] UN CSD. 2012.

[6] FAO 2013. Climate-Smart Agriculture Sourcebook

emissions compared to expected trends[7]". In line with this, the Kenya Climate Change Action Plan promotes CSA practices and strategies that reduce vulnerability, reduce emissions, and increase farming system resilience. Examples within the Action Plan include agroforestry, conservation tillage, and limited use of fire in agricultural areas, drought tolerant crops, water harvesting and integrated soil fertility management, among others.

Decision-making that embraces the complexity of CSA requires intentionally and strategically bringing together the relevant actors to share the best available knowledge and practices and weigh these toward the country's climate change goals. The majority of small holder farmers in the non-ASAL areas of Kenya undertake integrated farming systems that have components of agriculture, livestock, fish and trees, to serve food, feed, nutrition, energy and income needs. Within these systems, there is an array of practices such as agroforestry, conservation agriculture, integrated crop production systems, fish ponds, efficient grazing practices, mixed feed production, biogas production, energy saving cook stoves or the use of briquettes, among others. These practices can readily be integrated at the farm or at the landscape level. With this in mind it was seen as essential to give researchers, development practitioners, farmers and policy makers a central fora to present evidence, experience and share ideas. However, gaps still exist in the empirical evidence of the benefits of these practices, the opportunities to offset emissions and enhance adaptation with combinations of practices and contextual differences.

In October 2014, the Climate Change Unit of Ministry of Agriculture, Livestock and Fisheries of Kenya along with the Food and Agriculture Organization of the United Nations (FAO), The World Agroforestry Center (ICRAF) and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) convened a workshop for this purpose; to engage stakeholders from research, practice and policy to interactively share and analyze scientific evidence and field experience from over 40 projects. The aim of the workshop was to provide a summary of the current state of knowledge on CSA within integrated farming systems, allowing researchers and practitioners to engage with decision makers to develop joint and targeted messages for climate change policy making. The workshop focused on the importance of applying CSA in integrated systems at the farm and landscape level.

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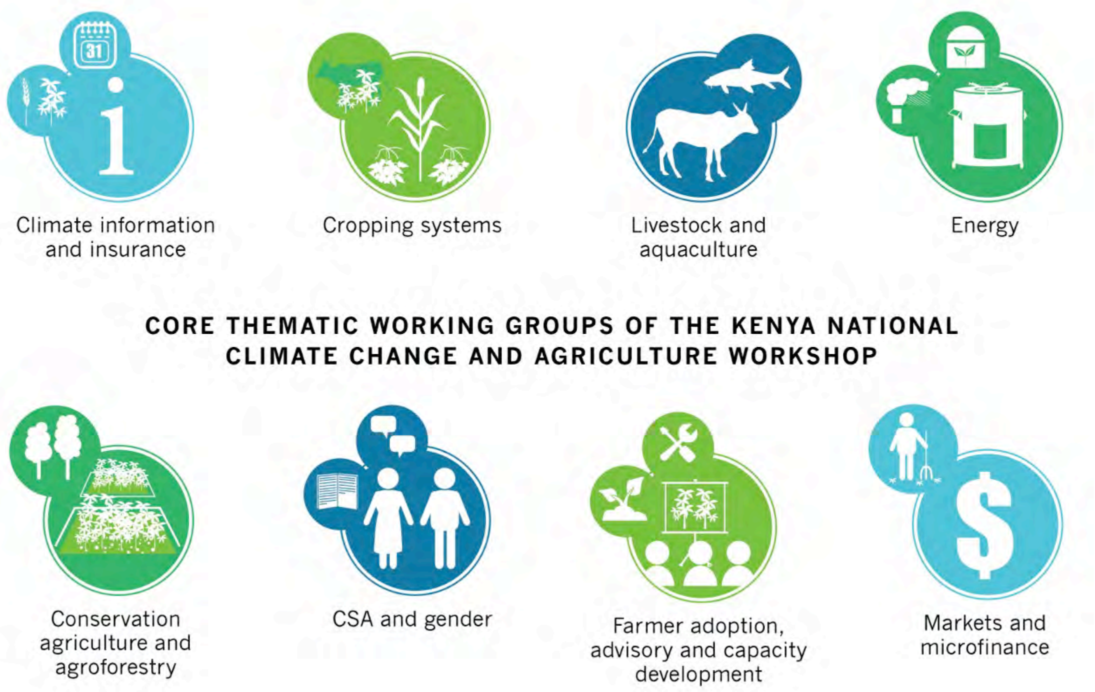
[7] http://www.fao.org/3/a-i4226e.pdf

The technical brief provides a methodological background on how actors from different knowledge domains were engaged, an overview of evidence and experience presented and the resulting joint development of policy messaging. In addition, a detailed summary on the state of CSA within Kenya is given. This is followed by a summary of the key joint discussion areas and recommendations agreed to at the workshop, as well as a detailed presentation of evidence from the eight core thematic working groups, including programmatic recommendations from each section.

Figure 1: *The eight core thematic working groups of the Kenya National Climate Change and Agriculture Workshop*



2. Methodological approach: preparatory process and convening principles

2.1 Preparatory Process

The core objectives of the Kenya National Climate Change and Agriculture Workshop were to engage research, practice and policy stakeholders to interactively share scientific evidence and field experience, in order to summarize the current state of knowledge on CSA within integrated farming systems in Kenya and to provide targeted messages for decision makers. The workshop aimed at raising awareness and understanding of opportunities and trade-offs with climate-smart agriculture and the value of integrating relevant sectors and institutions.

As part of the preparatory process, a scoping study on CSA in Kenya's integrated crop-livestock farming systems was commissioned by FAO to identify on-going, government-led CSA initiatives, including policies, laws, strategies, programs and actions in Kenya. This scoping study served as a basis for introducing the current Kenyan government context. Moreover, an open call was sent to organizations working on climate-related activities in order to gather their inputs for the workshop. Inputs were further reviewed and grouped by themes.

Experts presented over 44 projects, scientific evidence and field-based experience, in thematic working groups throughout the first day of the workshop.

The working groups included:

- Climate information and insurance
- Cropping systems
- Livestock and aquaculture
- Energy
- Conservation agriculture and agroforestry
- CSA and gender
- Farmer adoption, advisory and capacity development
- Markets and microfinance

Interactive working group sessions focused on combining quantifiable evidence on CSA with experience on field implementation of CSA and mechanisms for scaling up CSA. This was summarized through the presentation of a joint submission by each group, detailing the key outputs, knowledge gaps and programmatic recommendations. This in-depth technical analysis was presented to the high-level decision makers, policy makers and donors who convened on the second day of the workshop.

The pre-requisite inputs provided by the participants and organized by the facilitation team fast-tracked the process of bringing evidence and experience together from different knowledge domains. Guided facilitation allowed for the participants to explore complementarities and tensions associated with agriculture and climate change and come to conclusions to better support the desired outcomes of the Kenya Government and partners.

During an interactive plenary session, participants explored the dimensions of CSA with a specific focus on its application in Kenya. This critical unpacking of CSA allowed participants to articulate how CSA serves to achieve Kenya's development goals and climate change targets simultaneously. This effort, in combination with integrative analysis of the projects and experiences presented, allowed for the development of joint messaging and policy recommendations for immediate input to the revision of the Draft National Climate Change Policy Framework (2014). Further, the workshop delivered evidence-based and jointly agreed upon messaging regarding CSA, as a contribution to the policy dialogues of the UNFCCC (COP 20, December, Peru[8]) and other international efforts and fora, including the Alliance for Climate-Smart Agriculture in Africa.

2.2 Convening and facilitation based on principles of the Stakeholder Approach to Risk Informed and Evidence-Based Decision-Making (SHARED)

The ICRAF-developed Stakeholder Approach to Risk Informed Evidence Based Decision Making (SHARED) is a demand driven engagement framework for multi-sector and multi-institutional co-learning across research, practice and policy and co-negotiation of messages and actions to support mutually agreed upon outcomes and investment priorities. The principles of the ICRAF SHARED approach were tested in both the planning and the execution of the workshop, to facilitate the bridging of knowledge systems and evidence bases.

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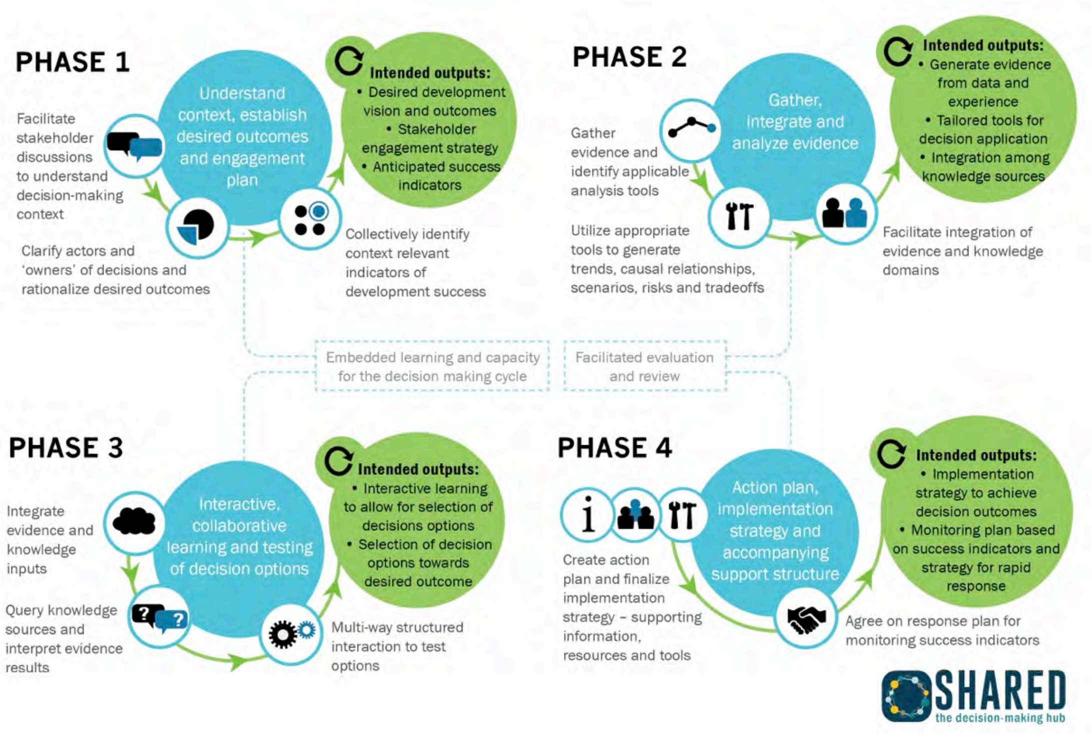
[8] FAO. 2014. http://www.fao.org/climatechange/42101-052030dc948c02b143ca95a7f96cdc7bb.pdf

In the months leading up to the workshop, focus was placed on setting up decision boundaries (integrated crop-livestock-fish-tree systems in non-ASALs) and desired outcomes (based in Kenya Vision 2030 and desired policy outcomes). The workshop organizing committee engaged specifically with the Climate Change Unit (CCU) within the MALF, in order to set parameters, define farming systems of interest that could integrate different sectors and help identify resource persons engaged in CSA.

In order to initiate the process of integrating and communicating evidence across the 44 projects, field experiments and farmer evidence that were submitted by multiple resource persons and institutions, the organizers undertook a targeted engagement of the identified resource persons, with data and experience, who were given a template for synthesizing their respective results, evidence and the implications for future programming. These 5-7 slides, provided in advance of the workshop, were printed and grouped on pin boards to support a "low tech" and highly interactive dialogue.

Figure 2: *The four phases of the ICRAF Stakeholder Approach to Risk Informed Evidence Based Decision Making (SHARED) Framework*[9]



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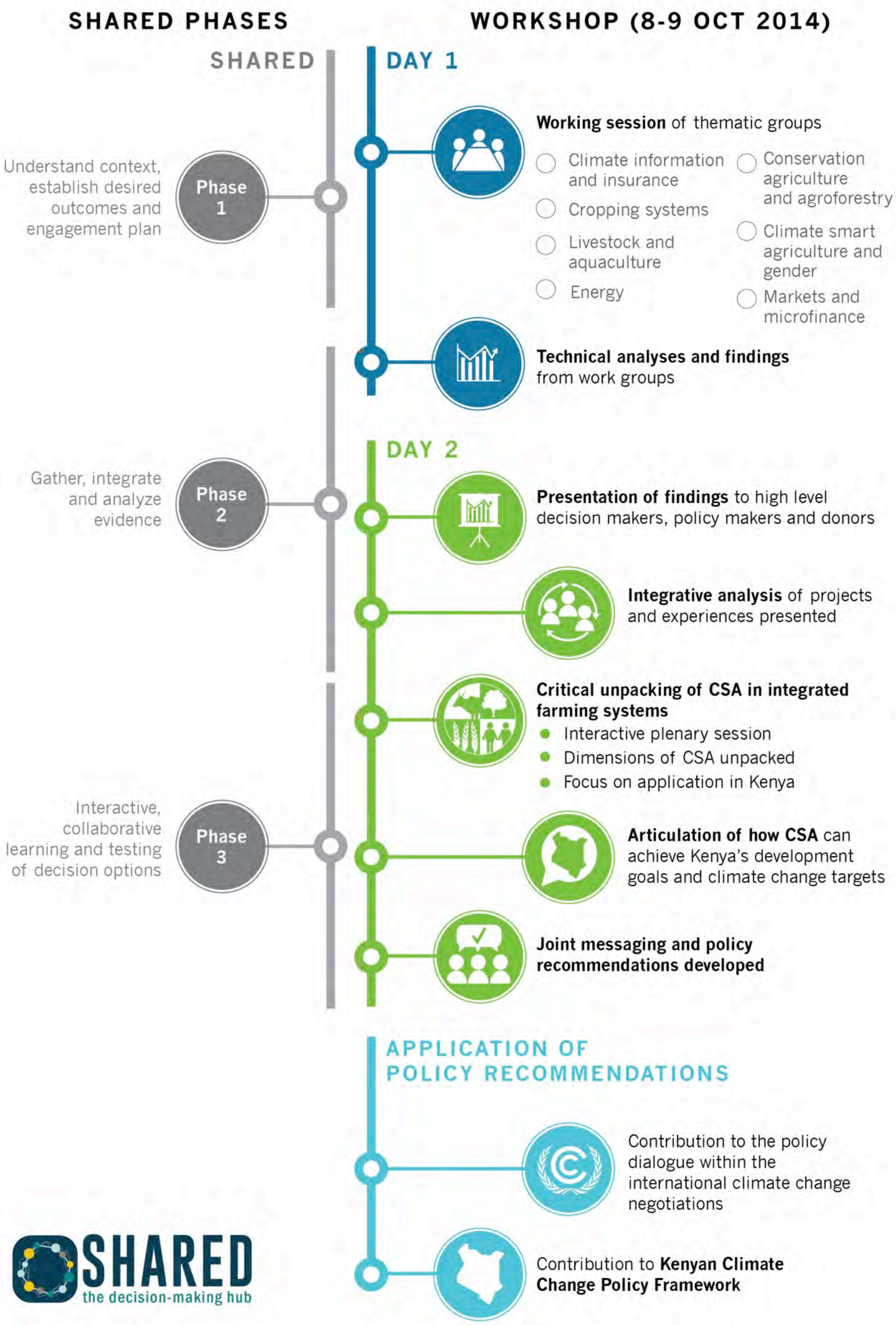
[9] ICRAF 2015 (SHARED@cgiar.org)

In the preparation for and execution of the 2-day workshop, ICRAF SHARED Phase 1-3 (see Figure 3 and 4) was implemented as a targeted approach to co-learning and knowledge sharing amongst these multiple resource actors. Stage setting was provided in highlighting the current Government of Kenya's CSA policy context, as identified in the FAO scoping study[10]. During the highly informative and interactive working group sessions held on the first day, thematic working groups were assisted in the interrogation of evidence, with a focus on quantifiable evidence and key research and outreach processes. The facilitation concentrated on getting the thematic groups to draw out information from the projects presented, synthesize key evidence and deliver a jointly developed presentation, which also identified gaps and recommendations targeted at programming. During these sessions, the thematic group members also queried to articulate complementarities and potential tensions among the elements of the integrated systems.

On the second day, a coherent presentation of the insights and recommendations that emerged from the technical and process dialogue was presented to a wider group of participants that included additional policy makers working on climate change within the CCU and the CC Secretariat, as well as donors. The CCU members and members of the CC Secretariat of the Ministry of Environment, Water and Natural Resources discussed and jointly evaluated the technical efforts, and developed policy messages to contribute to the Kenya Climate Change Policy Framework and COP 20 in Peru.

[10] Osumba, J and Rioux, J. 2015. Scoping study on climate-smart agriculture in Kenya: Smallholder integrated crop-livestock farming systems. FAO, Rome.

Figure 3: *Overview of the Kenya National Climate Change and Agriculture Workshop and its links to the ICRAF SHARED framework phases*



3. Overview of current policies of Government of Kenya on CSA-related activities

The CSA related policies of the government of Kenya are found in a series of national and regional documents. Policy makers have recognized the risk of climate change and the need to address these challenges. Policy efforts in Kenya demonstrate a high level of commitment to mainstreaming adaptation and mitigation goals into planning processes, and outline potential measures for doing so. The current official position of the Kenyan government is to first increase adaptation/resilience to enable farmers to increase and/or sustain productivity in the face of climate change and, where possible and feasible, to do this in a way that also mitigates greenhouse gas emissions through low emissions development[11].

Table 1: *Policies relevant to agriculture and climate change are contained in the following official documents*

Document	Relevance to Agriculture and Climate Change Policy
Draft National Climate Change Framework Policy (2014)	Policy statements to enhance climate resilience and adaptive capacity; to promote low carbon growth; and to mainstream climate change into the planning processes
National Climate Change Action Plan 2013-2017 (NCCAP executive summary, 2012, and NCCAP, 2013)	To implement the National Climate Change Response Strategy (NCCRS)
The Agriculture, Fisheries and Food Authority Act 2013	Provides for "policy guidelines on development, preservation and utilization of agricultural land"
Crops Act 2013	Makes provisions requiring farmland users to cultivate and make the land economically productive in a "sustainable and environmentally friendly manner"
National Agribusiness Strategy (2012)	Emphasizes the need to "improve risk management capabilities and insurance schemes", along with better information on risks (climate, diseases, market trends etc.) and how to overcome them
The National Disaster Management Policy (2012)	Institutionalizes disaster management and mainstreams disaster risk reduction in the country's development initiatives
National Food and Nutrition Policy (2011)	Recognizes climate change as an emerging issue for food and nutrition security; advocates for adaptation; recognizes the role of mitigation in addressing climate change
The Constitution of Kenya (2010)	Chapter 5 on Land and Environment – for sustainable Natural Resource Management; requires tree cover of at least 10% of the

[11] Government of Kenya. 2012. National Climate Change Action Plan Executive Summary.

	land area of Kenya; indigenous knowledge of biodiversity and the genetic resources of the communities (Chapter 5: Land and Environment)
CAADP Compact of NEPAD (Comprehensive Africa Agricultural Development Program of The New Partnership for Africa's Development) (2010)	Land and water management; incorporating CSA into national and local programs; The New Partnership for Africa's Development
National Climate Change Response Strategy (NCCRS, 2010)	Various measures for adapting agriculture to climate change and for mitigating the emissions of greenhouse gases in agriculture
Agricultural Sector Development Strategy (2010)	Sustainable Land and Natural Resource Management – borrows heavily from the NCCRS
East African Community Climate Change Policy (2010)	Emphasizes the need for an integrated, harmonized and multi-sector framework for responding to Climate Change in the EAC region
The National Land Policy (2009)	Intensification of use in high-potential, densely populated areas, through the application of efficient methods; improvement of the condition and productivity of degraded lands in rural and urban areas; application of cost-effective irrigation methods in areas of low agricultural potential
Kenya Vision 2030 (2008)	Wider environmental issues in general

Priority actions for low emission, climate-resilient development pathways, identified in the National Climate Change Action Plan (NCCAP) 2013-2017, emphasize a focus on agriculture and environment. Four of the following six identified priority actions pertain to agriculture: CSA and agroforestry, restoration of forest and degraded lands, improved water resource management, clean energy solutions (including improved cooking stoves and biogas digesters), geothermal power generation and infrastructure. NCCAP also details its priorities for adaptation and mitigation.

Table 2: *Adaptation and mitigation options recognized within the climate change strategies associated with agriculture in the National Climate Change Action Plan*[12]

NCCAP Adaptation Options	NCCAP Mitigation Options
• Agroforestry • Conservation agriculture and integrated soil fertility management • Drought tolerant crops • Water harvesting • Drip irrigation	• Agroforestry: Increase tree cover to 10% of total land area • Conservation tillage and limiting use of fire in cropland • Restoration of forest on degraded lands • Avoiding deforestation with REDD+

[12] Government of Kenya. 2013. National Climate Change Action Plan 2013 - 2017 Executive Summary, Nairobi Kenya

• Price stabilization scheme for livestock • Strategic food reserve • Index-based weather insurance • Climate information • Mainstream climate change into agricultural extension services • Grazing systems management, fodder banks and breeding (ASALs) • Livelihood diversification	• Rangeland management • Improved cook stoves and biogas units

Agriculture and forestry sectors are the largest emitters of greenhouse gases in Kenya, accounting for approximately 72% of emissions in 2010 and a projected 65% in 2030 - mainly due to emissions from livestock and deforestation[13]. While emissions from agriculture will increase, emissions from deforestation will decrease up to 2030 because of improved forest management and governance. In agriculture, the major GHG emissions sources include enteric fermentation (56%) and manure left on pasture (38%)[14] Potential reduction of GHG was estimated as in Table 3. Potential impacts of improved cook stoves and biogas and mainstreaming climate change into agricultural practice were not yet quantified but provide additional emissions reduction potential.

Table 3: *Estimation of mitigation potential associated with environment and agricultural strategies and practices*[15]

NACCP Mitigation Options	Estimated Mitigation Potential (CO_2 equivalents)
Restoration of forest on degraded lands (conservation and sustainable forest management)	30 Mt a year in 2030
Reforestation	6.1 Mt
Reduction of Deforestation and forest Degradation (REDD)	1.6 Mt
Agroforestry	4.2 Mt by 2030
Conservation tillage and limiting use of fire in cropland	1.1 Mt by 2030
Rangeland management	1.2 Mt by 2030

[13] Government of Kenya. 2012. National Climate Change Action Plan p66.

[14] FAOSTAT. 2014

[15] Government of Kenya. 2013. National Climate Change Action Plan 2013 - 2017 Executive Summary, Nairobi Kenya

3.1 Existing government CSA initiatives

Since 2001, the Ministry of Agriculture, Livestock and Fisheries of Kenya (MALF) has undertaken over 11 CSA related initiatives – the majority of which have been implemented in ASALs[16]. Additional initiatives that contained elements of CSA were included even if not specifically labelled as CSA or originally designed with a climate change lens. Supportive and coherent policies and strategies, including those on climate finance, are evidence that political goodwill for CSA exists in Kenya. However, a number of challenges also exist, as presented during the workshop.

"The Government's goodwill to address climate change is very high. Multiple stakeholders have been engaged in the process of developing a climate change response strategy for Kenya. Both adaptation and mitigation are important, although the short-term priority is adaptation. Nevertheless, addressing the root cause of the problem requires reductions of greenhouse gas emissions produced by agriculture." (Moses Omedi, Deputy Director of the Climate Change Secretariat of the Ministry of Environment, Water and Natural Resources)

The Ministry of Agriculture, Livestock and Fisheries has already established a CSA Task Force that is open for new stakeholders. Currently, the Task Force consists of representatives from government, the research community and farmers' organizations.

3.2 Challenges to mainstreaming CSA in Kenya

As with other mainstreaming efforts that have gone before, there are always obstacles that need to be addressed to achieve a tipping point toward success. The specific challenges to CSA in Kenya were summarized as follows (Osumba & Rioux, 2015[17], adapted from NCCAP, 2012[18]):

- Land tenure insecurity limits CSA adoption and needs to be both recognized and addressed to make investments worthwhile.

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[16] Osumba, J and Rioux, J. 2015. Scoping study on climate-smart agriculture in Kenya: Smallholder integrated crop-livestock farming systems. FAO, Rome

[17] Osumba, J and Rioux, J. 2015. Scoping study on climate-smart agriculture in Kenya: Smallholder integrated crop-livestock farming systems. FAO, Rome.

[18] Government of Kenya. 2013. National Climate Change Action Plan 2013 - 2017, Nairobi Kenya

- Systematic quantification of the benefits of CSA must be carried out.
- Impacts of CSA need to focus on the whole system, current studies tend to focus on specific practices in isolation and subsequently impede the potential synergies within the farming and landscape system.
- There is an overall need for increased access to knowledge, information and practices
- Climate finance is limited internationally and nationally. Donor and investor finance must be harmonized to enable acceleration of impact across the country.

3.3 Steps forward from the NCCAP

The steps forward for mainstreaming CSA in Kenya (Osumba & Rioux, 2015[19], adapted from NCCAP, 2012[20]) are:

- Include an operational national CC secretariat within the coordinating ministry responsible for coordination and national reporting obligations
- Develop knowledge sharing systems and a capacity development strategy
- Mainstream CSA in planning process at national and sub-national levels
- Identify and remove barriers for adaptation and mitigation
- Put in place a national performance and benefit measurement system (NPBM) for measuring, reporting and verification (MRV) of adaptation, mitigation and synergies
- Encourage investment in CSA and set up a national climate fund and carbon trading platform
- Move forward the action plan through climate finance mechanisms like GCF (Green Climate Fund), Adaptation Fund, Nationally Appropriate Mitigation Actions (NAMAs), National Adaptation Plans (NAPS) and REDD+

3.4 Adaptation and mitigation plans

A comprehensive National Adaptation Plan (NAP) was drafted for Kenya in 2012/2013 to accompany the NCCAP, based on assessments of development needs and climate vulnerability. NCCAP considered the development of NAMAs for the priority sectors of CSA and agroforestry, restoration of forest and degraded lands and clean energy solutions. The

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[19] Osumba, J and Rioux, J. 2015. Scoping study on climate-smart agriculture in Kenya: Smallholder integrated crop-livestock farming systems. FAO, Rome

[20] Government of Kenya. 2013. National Climate Change Action Plan 2013 - 2017, Nairobi Kenya

development of the NAMA framework is still in the pipeline, and there is an interest from the MALF to develop a NAMA on dairy livestock in the near term.

4. Summaries of the thematic working groups' evidence

The following section expands on the thematic working groups by detailing key institutions and projects as well as activities that were presented. The primary results from the field evidence are summarized, as are the joint recommendations drafted by the experts within each of the thematic working groups. Further details on the individual projects can be found in the supplementary material to this report.

4.1 Climate information and insurance

Authors: Shadrack Kipkemoi (ASDSP), Jeanne Coulibaly (ICRAF), Lydia Nyambura, Bernard Mbogo (CARE), Michael Okumu (CCU MALF)

4.1.1 Background to climate information and insurance

Effective decision-making for adaptation interventions is informed by past, present and future climate information, enabling plans and actions for climate-resilient livelihoods and disaster risk reduction. Greater access to climate information is therefore key to the management of climate risk and to improved responses to future challenges, through enhanced decision-making, productivity and resilience.

Improving the use and access of weather information is a central area of adaptation and a promising area of development for CSA. Through various projects implemented in Kenya's ASALs, institutional actors have worked to develop strategies for providing locally specific weather information that can improve farmers' and pastoralists' ability to make timely farm-level decisions, and to ensure that information is accessible in local languages via efficient and appropriate channels. The efforts also aimed to complement weather information with additional advice on the best agricultural practices relevant for the available weather data, and to facilitate a support system that enables farmers to take informed action - including the support of inputs market, credit mechanisms, etc.

Table 4: *Contributing institutional efforts regarding climate information and insurance*

Institution	Project[21]
Agricultural Sector Development Support Program (ASDSP)	Agro weather information for adapting to climate change (capacity development)
ICRAF	Climate Information Services for farmers in Kenya (research; development)
World Vision Kenya	Index Based livestock Insurance (development)
CARE-Kenya	Kilimo Biashara (capacity development)

4.1.2 Activities

Baseline surveys to understand farmers' needs in order to design tailored climate products were completed by CCAFS in the Nyando district of Kenya, working with the Kenyan National Meteorological Services and National Agricultural and Extension Services.

Partnerships and a multi-stakeholder platform were launched by ICRAF, enabling the sharing, understanding, interpreting and communicating of information. The multi-stakeholder platform provides an essential space for dialogue on local adaptation issues, the room to create strong synergies among stakeholders and an avenue through which combining local and scientific knowledge is possible.

Financial resources to ensure against risk were mobilized in projects completed by World Vision and CARE-KENYA. Using insurance as a proactive risk-management solution, World Vision implemented the Index Based Livestock Insurance pilot project (IBLI - Pilot 2). The project used the Normalized Difference Vegetation Index (NDVI), an index for estimating spatial vegetative land cover data, to better predict and manage drought-induced risks by insuring those vulnerable to detrimental shocks and thereby enhancing pastoralist livelihoods. Under the program, complementary services were provided to farmers based upon ground cover satellite photographs and evident zones of drought severity. Insurance policyholders who enroll annually are paid out when their zones appear in the highest risk zones and are eligible to receive premiums following each rainy season, at a ratio of the value of their livestock.

[21] See the supplementary material to this report for more detail

CARE's Biashara Project (Pilot 3) aimed to improve the prospects of adaptation by facilitating access to market and financial resources, to enable farmers to make strategic diversification changes in their farms. The project did so by increasing access (capacity + proximity) to credit for farm inputs via village savings and loan associations (VSLA). Increasing access to these financial resources aimed to facilitate improvement in the value chains of sugar snaps, green beans and baby corn in the Nyandaru, Nyeri and Kirinyaga counties of Kenya and to ultimately improve the livelihoods of outgrowers (a variation of contract farming).

4.1.3 Overview of results

Results of these efforts confirmed that climate information and insurance are helpful tools for improving the adaptation and resilience of Kenyan farmers. Weather advisories significantly improved the farmers' capability and capacity to cope with climate variability and change. Farmers also embraced water-harvesting technologies and benefited from improved harvests. By providing a source of security through better access to financial capital, the Biashara project supported more resilient livelihoods. VSLA groups achieved a total accumulated savings of KES 3,873,860 and were able to access total accumulated loans of KES 5,172,860. Access to financing provided farmers with the resources needed to make beneficial decisions: farmers were able to diversify crops to spread risk; adopt agroforestry to utilize both shorter term tree crops for quick income and longer term crops for 'pension' security; and to increase the use of rotational cropping in order to better manage the risks of pests and address declining soil fertility.

Learning outcomes of the projects indicate that the scaling up of these practices should emphasize the accessibility of information for farmers as well as enhanced decision making skills for targeting interventions to maximize return on investment. The baseline survey established that, in order to be useful to farmers, information must be downscaled to be locally specific, presented in local languages and delivered in a timely and reliable manner. The most promising avenues for information dissemination indicated were by radios, cell phone/SMS and through local social networks. Furthermore, climate information must not stand alone but should rather be accompanied by the provision of improved crop management systems and climate-smart technologies that can assist farmers with selecting tailored solutions to address challenges explained in the forecasts. Climate information can accompany agricultural practice advisory services by being integrated into the existing channels of farmer extension services. Furthermore, direct actions taken by farmers as a result of climate information are dependent upon their wider practical cohesion with the surrounding institutional environment, such as input markets access and availability of credit mechanisms.

Table 5: *Overview of key activities, results and recommendations regarding climate information and insurance*

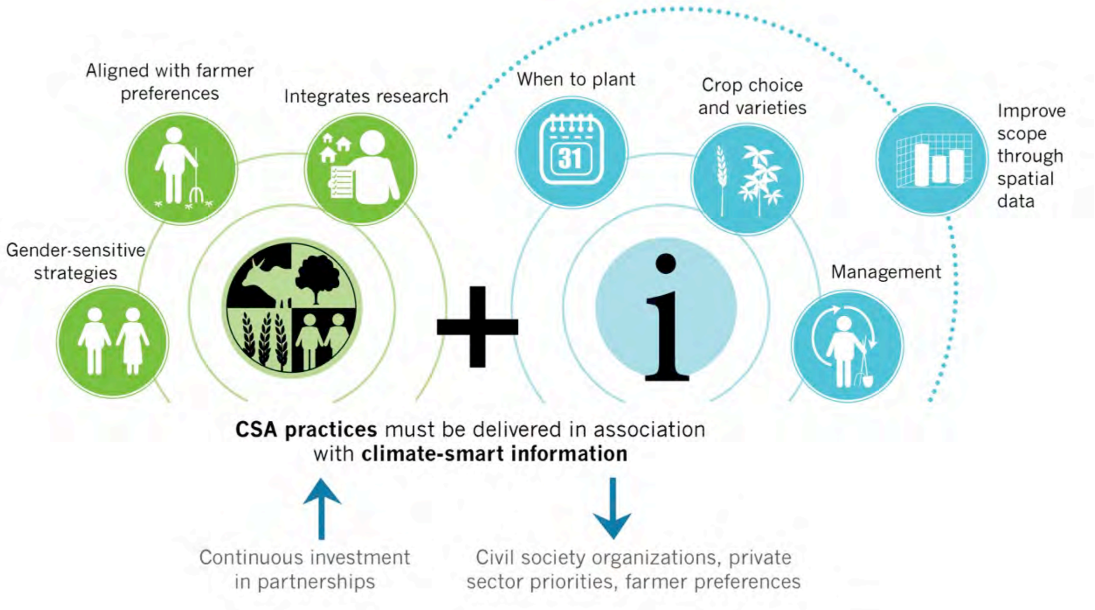
Key Activities	Results
• Baseline studies to understand farmer needs • Multi-stakeholder platform • Insurance program • Village savings and loan associations	• Farmers' adaption improved by weather advisories • Farmers enabled to diversify crops to spread risk • Information downscaled to be locally specific • Information presented in local languages via locally appropriate channels • Wider enabling environment (i.e. input markets access and credit mechanisms) established to enable the required farmer action • Combined local and scientific knowledge systems, with locally relevant climate information and empowered communities • Climate information accompanied by advice on locally appropriate practice changes
Recommendations	
• To design relevant, tailored climate information products and services to the scale of farmers' decision making • Use local radios, information communication technologies (ICTs) to reach farmers at scale • Inclusion of climate information into agricultural extension services	

4.1.4 Insights and recommendations for future programming

- CSA practices are not enough on their own: they need to be delivered in association with climate-related information targeting farmers (that provides advice on when to plant, crop choice, varieties to plant, management, etc.)
- Apply gender-sensitive strategies (especially where men migrate leaving women as decision-makers)
- Integrate research to back-up development work, and vice versa, to ensure meaningful research
- Improve the scope of local information available through spatial data and facilitate its interpretation

- Running a multi-stakeholder platform, such as that launched by ICRAF, requires continuous investment in managing partnerships, leveraging CSO and private sector priorities and farmer preferences
- Farmer preferences are the key determinants for acting on climate information with appropriate measures - therefore, accompanying consulting services must remain aligned with the farmer preferences for less labor intensive strategies and low input costs

Figure 4: *Insights and recommendations for future programming*



4.2 Experiences from climate-smart cropping systems

Authors: Jeske van de Gevel (Bioversity), Sika Gbegbelegbe (CIMMYT), Mary Njuguna, Anthony Kibe (Egerton University), Steven Karania, Patrick Ooro (KALRO), Peterson Njeru (KALRO), Cyrus Githunguri (KALRO), Michael Okumu (CCU-MALF), Daniel Gichuhi (KENAFF)

4.2.1 Background

Institutional partners evaluated the pending risks to cropping systems in field sites throughout Kenya, analyzed the efficiency and improvement potential for current systems in place, as well as tested the potential benefits of some alternative CSA cropping system strategies. Projects were operated across several different scales, ranging from crop-specific strategies to strategies not specific to a particular crop, as well as through a holistic approach that considers cropping systems in their wider socio-economic, local and regional landscapes.

Table 6: *Contributing institutional efforts regarding cropping systems*

Institutions	Projects[22]
Bioversity International (Kenya, Tanzania)	Varietal Diversification to manage climate risks
International Maize and Wheat Improvement Centre (CIMMYT) (Kisumu: Nyando Makueni)	Foresight modeling / CCAFS
SNV	Income, food, and climate solutions for smallholder farmers
Egerton University (Nakuru: Rongai)	Enhancing sorghum and cowpea intercrop yields through manipulation of intercrop density and row orientation
Kenya Agricultural and Livestock Research Organization (KALRO) (Nakuru: Njoro)	CSA technologies for smallholder farmers (research)
KALRO/Kenyatta University (Nairobi : Muguga)	Integrating farmers perception and scientific methods for evaluating climate change
German Federal Enterprise for International Cooperation (GIZ)/MOAF, Homa Bay and Busia Counties	Enhancing farmers' adaptive capacity
Kenya National Federation of Agricultural Producers (KENFAP)	Composting: water conservation, water harvesting etc.
Revitalization of Indigenous Initiatives for Community Development (RINCOD), Mutomo Sweden Group and KALRO	Cassava farming transforming livelihoods among smallholder farmers in Mutomo, a semi-arid district in Kenya

[22] See the supplementary material to this report for more detail

Table 7: *Overview of key activities, results and recommendations regarding climate-smart cropping systems*

Key Activities	Results
• Literature research and case studies on local, and regional climate risks • Modeling projections for risks and crop production by 2050 • Biodiversity assessments • Evaluation of locally appropriate crops and varieties • CSA practices tested *in situ* at the farm level: intercropping; improved light penetration to understorey crops; crop diversification; improved soil management; water conservation • Local promotion of cropping system CSA practices • Demonstration plots • Farmer groups • Capacity building and training of trainers in cropping system diversification • Agriculture insurance	• Maize suitability changes vary across Kenya • Kenya experiences changes in different local climate patterns • Improved intercropping maximizes productivity and water use efficiency • Biophysical and economic context allows for cassava diversification in Mutomo (but resulting cropping calendar changes interfere with pastoralist grazing) • Integrating oxen plough to make furrows for rain water harvesting and erosion control is found to be a successful practice • Ridges, farmyard manure and green manure have a positive influence on soil moisture accumulation • Training of farmers increases their knowledge and thus reduces their vulnerability • Implementing CSA via local service structures is beneficial • Opportunities for adaptation exist in changes in crop and livestock-related activities and group formation • Solar radiation incidence on shorter component crop canopy can be optimized or enhanced by orienting intercrop rows in an East – West direction • Additional government support may be necessary to trigger insurance products for small scale subsistence farmers
Recommendations	
• CSA interventions need to take on a holistic approach • Private sector incentives must be compatible with CSA practices to invite adoption by farmers • CSA crop management technologies need to maximize the use of local organic sources and focus on low input requirements • Harness the benefits of organic sources of fertilizer to enhance soil moisture retention (a critical concern in variable climate situation) • Increase the presence of agroforestry trees in cropping systems for their multifunctional benefits • Climate change adaptation should be systematically integrated in all agricultural projects and programs • In order to demonstrate results, project interventions need to have a specific time frame to show effects sustainably	

- Further studies are needed to evaluate preliminary results reported

4.2.2 Activities

Research on current climate risks and adaptation strategies of smallholder farmers was conducted by the International Maize and Wheat Improvement Centre (CIMMYT). A literature review in Eastern Africa and case studies on Nyando and Wote, Kenya, provided a better understanding of the local and regional situation on climate change and smallholder farmers. CIMMYT also completed bio-economic modelling to quantify a forecasted impact of climate change on maize productivity and food security in Africa by 2050.

Current practices and their alternatives formed the subject of several other studies that looked at intercropping, crop diversification, improved soil preparation and water conservation practices, and surveyed their appeal and adoption by farmers.

Despite the popularity of intercropping systems in Kenya, information on the effects of intercropped populations and row orientation in sorghum-cowpea intercropping is limited. Crop competition/interaction can have significant impacts on growth factors, such as soil moisture and solar radiation interception, which limit yields. A better understanding of these systems is important to assist efforts to improve crop management and increased food grain production. Egerton University conducted an experiment to determine the influence of cowpea intercrop population and row orientation on crop evapotranspiration (ETc), water use efficiency (WUE), solar radiation interception and yields, in a sorghum-cowpea intercrop systems. The site had a sandy clay loam soil, classified as *mollic andosols* in the sub-humid environment of Rongai, in the Rift Valley of Kenya (1768 meters above sea level).

KALRO evaluated climate-smart production technologies for smallholder potato farmers and the water harvesting and productivity potential under different soil management practices, namely tied ridges, contour furrows and farmer practice control, at the edge of the Mau escarpment in the Njoro sub-county. Green manure from *Leucaena spp* and farmyard manure were used and were found to significantly increase moisture retention, thus enhancing adaptation to climate variability.

In the Mutomo district of Kenya, much like in other semi-arid regions, farmers continuously grow maize and beans season after season despite frequent crop failures. There is a real need to introduce drought tolerant crops like cassava and sorghum, in order to address food insecurity in such areas. Due to the higher carbohydrate yield efficiency of cassava in stressed agro-ecological conditions, it was selected for inclusion in Mutomo cropping systems to improve food security. Under the support of RINCOD, Mutomo Sweden Group and KALRO, a plan for the reliable production of elite cassava varieties began. Cassava agronomic demonstrations, seed multiplication and distribution programs were established in order to assure processors of a steady supply of tuberous roots. The community first selected three farms for cassava propagation and planted 10,000 cuttings on each, and later distributed the cuttings from the initial three farms to 100 members who were selected based on their commitment to grow cassava on at least a quarter of an acre of their farm in order to meet supplier needs. The project also provided training for the management of the mosaic disease and the incorporation of furrows, big ridges and inverted bottle irrigation techniques to improve water management for production

Research carried out by Bioversity International's Seeds for Needs project focused on crop diversification in Kenya. Bioversity conducted inter- and intraspecific diversity assessments, devised varietal adaptation and risk management strategies, compiled crop suitability mapping, organized participatory varietal selection and investigated climate-smart varieties. The project questioned the extent to which farmers are planting different crops or varieties, how climate change affects varietal diversification strategies and which traits farmers seek in new potential climate-smart varieties. In the next phase, the project will continue by conducting a seed network analysis, working within identified marketing channels, further developing crowdsourcing methodology, supporting participatory plant breeding of locally specific climate-smart varieties and promoting climate-smart seed systems. Bioversity plans to continue to research and promote the most promising technologies.

The approach of the Netherlands Development Organization (SNV) attempted to integrate a set of CSA tools to improve sustainability at the farm level, business landscape and climate-smart agricultural landscape. SNV projects wove together a basket of CSA best practices in key commodity systems (rice, cocoa, coffee, shrimp aquaculture, livestock, dairy and horticulture). In the avocado value chain, SNV linked private sector demand and smallholder producers. SNV also implemented a multiple tool approach in the dairy sector to improve mitigation results: the organization promoted more efficient cows (with higher milk productivity per cow), an improved management of biogas and slurry, the use of renewable energy for milk cooling, an improved feed management and regular quality control tests for feed and its regulation compliance.

The Ministry of Agriculture and the German Federal Enterprise for International Cooperation (GIZ) jointly implemented the Adaptation to Climate Change and Insurance (ACCI) project in Western Kenya, which aimed to enhance farmers' adaptive capacity in the region. The project trained 67 Ministry and Local Subsidy Partners (LSP) staff, availed CA equipment for demonstrations in seven districts, and supplied farm inputs for 195 demonstration plots. The project also financially supported five LSPs and seven sub-county agricultural offices to reach out to farmers with climate change adaptive strategies. The project also developed the TRAC methodology, sensitizing farmers in seven districts regarding climate change risks, and reaching more than 5000 producers via participation in 195 training groups and demonstration plots. Soil samples from the demonstration plots were analyzed and farmers briefed on their results. Among the adaptive strategies promoted were crop specific strategies for sorghum, cassava, sweet potato, maize and groundnut, and strategies not specific to any crop. Strategies not specific to any crop evaluated the benefits of varietal diversification as related to drought/heat tolerance, early maturing varieties, drought escaping varieties, conservation agriculture, agroforestry farming systems/farm micro-climate/tree planting (horti-silviculture), integrated pest management (pest resistant/disease resistant/weed tolerant varieties), integrated soil fertility management, good agricultural/agronomic practices and risk transfer strategies (agricultural insurance - Index Based Weather Insurance). Staff members were also trained on agricultural insurance, which enabled them to sensitize farmers to access available insurance products in the market.

4.2.3 Overview of results

The results of cropping systems initiatives in Kenya exposed the risks and vulnerability of current systems, tested CSA solutions in local contexts and provided important lessons regarding the implementation of training for CSA systems.

Changes in local climate patterns are expected to change the suitability of crops throughout regions of Kenya, according to CIMMYT's studies. Results exposed risks of increased temperature, decreased rainfall and a change in rain onset and/or cessation. Highly suitable areas for cowpea production in Kenya are expected to increase by 2050, compared to levels in

2000. Likewise, Kenya can expect a 7-12% increase in suitable maize area by the 2050s. While overall maize production will increasingly become more suitable to the highlands, the simultaneous decreases in maize potential in other more marginal areas may cause negative effects on food security. The rising high dependency on maize as a staple food in the 2050s and the expected severe maize shortage on a global scale are cause for concern. In contrast, CIMMYT found that farmers' perception of weather changes are inconsistent with these worrisome measured risks.

Egerton University's cowpea/sorghum intercropping trials demonstrated the pronounced benefits of improved intercropping practices in cropping systems as a CSA practice option, and show the importance of locally based cropping system research. ETc, WUE, overall yields, biomass production and harvest index can be maximized by the knowledgeable maximization of the environment. The experiment determined that cowpea intercrop planting density was optimized for the sorghum-cowpea intercrop at 110,000 -125,000 cowpea plants/ha at max ETc of 695 and 517 mm for seasons I (SI) and SII (wet), respectively. The WUE of 4.0 and 5.5 kg/ha-mm was influenced by seasonal ETc in drier and wetter environments, respectively. East-West row arrangement was better for the shorter cowpea intercrop grain production while North-South row orientation was better for the sorghum crop. The productivity of both crops combined was also maximized with the North-South row arrangement, due to higher light penetration and incidence on the taller sorghum crop. The shading of taller component crop over the shorter associated (intercropped) crop can reduce the growth and yield of shorter component crops. This would be due to less incidence of solar radiation on the shorter crop canopy. Manipulation of the row orientation particularly in agro-forestry (horti-silviculture etc.) cropping systems can be done to effectively give an advantage to the shorter component crops (i.e. grain or pasture crops) grown as intercrops within taller fruit trees. This is possible if the rows are facing the East–West direction.

The feasibility of crop diversification strategies as CSA was considered through the cassava promotion project in Mutomo. The project allows for the more efficient use of locally available resources and diversification. Cassava growing was therefore deemed an effective mitigation and adaptation strategy. The products (fresh roots, cassava cuttings and cassava cakes) are popular in local markets and, provided that demand is sustained, cassava production is likely to become the choice crop for food security in the long term, compared to the failing maize/beans rotations. It should be noted, however, that growing cassava alters the production calendar. The longer vegetative period of cassava can interfere with the grazing calendar in semi-arid areas. Therefore, farmers need to protect their longer maturing crops with fences from grazing goats. This is likely to fuel conflict between farmers and agro-pastoralists.

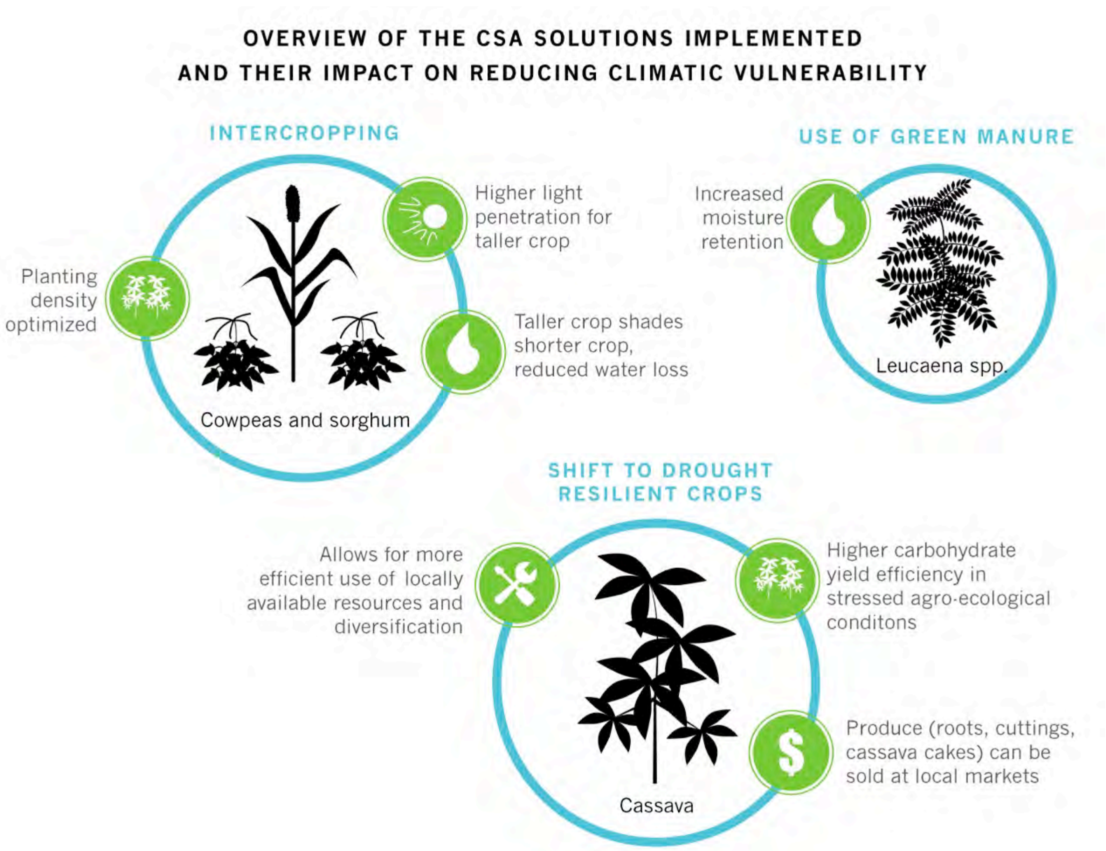
Integrating soil and water management methods into potato and sorghum production also highlighted the CSA potential of these practices in Kenya. KALRO found that, in smallholder potato and sorghum production, integrating the practice of tie ridges and the use of inorganic and organic inputs (fertilizers, farmyard manure and green manure) had the potential to greatly increase water retention in soils and increased crop productivity. On the other hand, inorganic fertilizer had no effects on soil moisture. In another site, a participatory study done in collaboration with Kenya Agricultural and Livestock Organization/Kenyatta University highlighted the benefits of using oxen plough with an intention of making furrows for rainwater harvesting, while integrated soil fertility management practices and soil erosion control resulted in increased sorghum productivity in drier areas of Embu County.

Adaptation options identified by CIMMYT include: changes in crop and livestock-related activities and corrective action (through group formation). Barriers to adaptation include lack of access to resources and knowledge needed to adapt. Climate-smart practices are deemed as essential to facilitating adaptation to climate change in the short and long term; however, CIMMYT research also reinforced the need for the strategic pairing of climate information alongside CSA practice solutions to overcome barriers.

SNV and the GIZ/MOALF partnership provided lessons about the implementation of CSA cropping system interventions within the broader socio-economic context in which CSA adoption takes place. The ACCI project has shown that climate change adaptation can be effectively addressed using existing local service structures, provided support is well organized and supervised implementation is guaranteed. Farmers stated that they have found the strategies taught in GIZ/MALF trainings to be useful in reducing their vulnerability. To reduce climate vulnerability of farmers, agricultural insurance for small-scale subsistence farmers may need repackaging that involves government reinsurance, since this niche of farmers may not make business sense for insurance service providers due to its high risk nature.

The SNV business landscape approach succeeded in facilitating inclusive business between Mara Farming and 700 smallholders in the out-grower model. Each smallholder had at least ½ an acre with a minimum of 40 trees/orchard and a projected income of at least Ksh 80,000 per season. The project can also be linked to larger scale environmental benefits, for example the resulting 400 acres/32,000 trees of smallholder production systems has zero deforestation impact. In addition, a 100-acre nuclear orchard sustains another 15,000 trees. A total of 700 smallholder out-growers manage climate friendly commercial farms, 332 households increased their resilience to climate change due to perennial cash crop diversification, extension support continues to encourage best management practices and, overall, the production systems reap the benefits from the practice of agroforestry intercropping.

Figure 5: *Overview of the CSA solutions implemented and their impact on reducing climatic vulnerability*

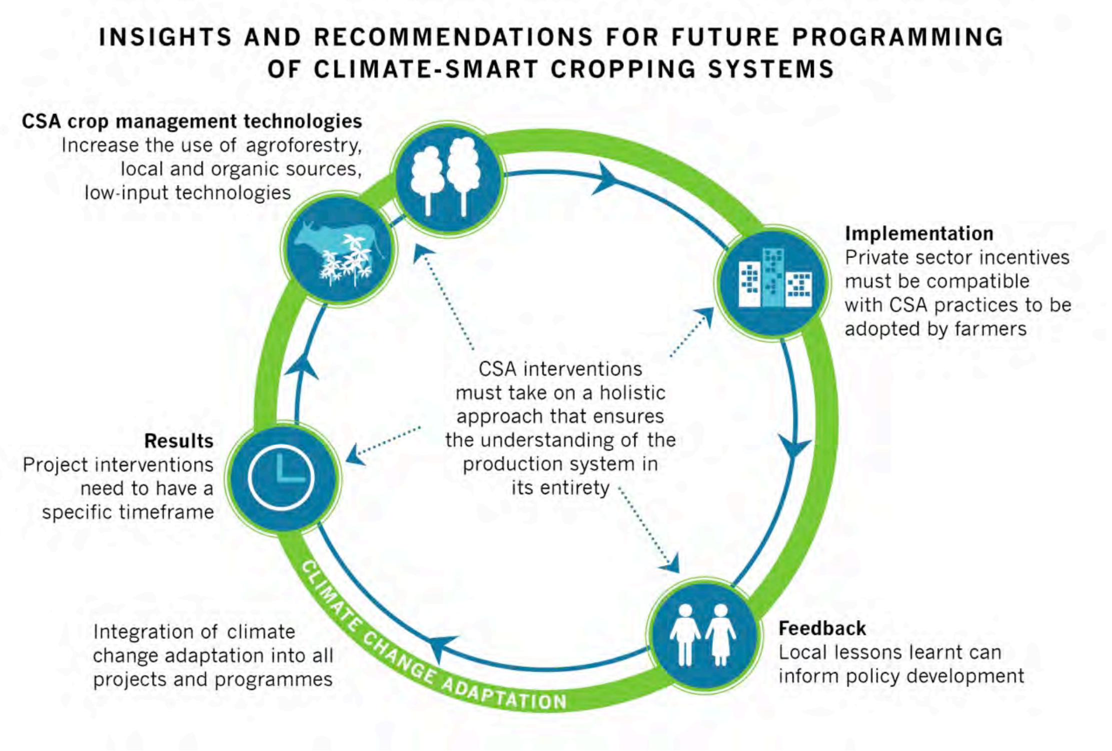


4.2.4 Insights and recommendations for future programming

Collaborating institutions highlighted the following key recommendations:

- CSA interventions need to take on a holistic approach that ensures the understanding of the production system in its entirety and the integration of the cropping systems within a larger socio-economic context.
- Private sector incentives must be compatible with the CSA practices to be adopted by farmers (as suggested by SNV). In addition, because integration can also take place at the landscape level, the social dynamics and equity at these scales should be considered.
- CSA crop management technologies need to maximize the use of local organic fertilizer sources and a focus on low input technologies. Harnessing the benefits of organic sources of fertilizer enhances soil moisture retention, which is critical in variable climate situation.
- Increasing the presence of agroforestry trees in cropping systems for their multifunctional benefits is advised.
- Climate Change Adaptation should be systematically integrated in all agricultural projects and programs. In turn, local "lessons learnt" can effectively inform policy development and the Kenyan position internationally.
- Project interventions always have a specific timeframe, which is usually too short to show effects and ensure sustainability. In order to demonstrate results, project interventions need to be aware of longer-term impacts / effects.

Figure 6: *Insights and recommendations*



4.3 Livestock and aquaculture

Authors: Todd Rosenstock (ICRAF), Todd Crane (ILRI), Daewood Idenya (Government Nandi Subcounty), Margaret Gatonye (AAK), Cyrus Githunguri (KALRO), Miyuki Iliama (ICRAF), Bethuel Omolo (Fisheries), Inger Haugsgjerd (UNEP), Jackson Kibenei (EADD), Carolyn Opio (FAO).

4.3.1 Background

Livestock has an important economic and traditional role in Kenyan agriculture. Livestock accounts for 40 and 10 per cent of the agricultural and national GDP, respectively. Dairy products contribute 30% of livestock GDP and 3.5% of the national GDP. Estimated to have grown by an average of 4 to 5% per annum in the last decade, the sub-sector produced approximately 5.0 billion litres of milk in 2012. Over 800,000 smallholder farmers in Kenya depend on dairy farming for their livelihoods. Small-scale farmers account for 80% of the total milk production and 70% of the total marketed milk in the country. This has positive implications on food security and nutrition and has the potential to reduce poverty, particularly in the rural areas.

However, the sector is faced with a number of challenges, most notably the need to meet increasing demand for livestock products within a constrained system characterized by resource scarcity, changing climate and other environmental concerns. Changes in climate and climate variability will affect livestock production systems in Kenya. The increasing frequency and severity of extreme weather events associated with climate change, such as drought and floods, are a serious threat to the dairy sub-sector that will have direct effects on animal health, wellbeing and production (e.g. growth, reproduction, milk production). Increasing temperatures and shifting rainfall amounts and patterns will clearly have impacts on crop and livestock agriculture. Feed availability will remain a critical constraint on livestock production.

Livestock production is a significant source for agricultural GHG emissions. Kenyan dairy farming results in high GHG emissions per unit of product - e.g. 5.7 versus 2.8 kg CO_2 eq./kg fat and protein corrected milk at global level. Methane gas (CH_4) from the livestock industry is the single largest source of agricultural emissions, contributing between 50-60% of the total emissions. The increasing potential for the future growth of the industry in Kenya suggests an opportunity for limiting emissions per kg of product, along with increasing the scale and productivity of the sector. Institutional partners have worked to adapt the methodology for evaluating livestock emissions to small-scale farming in Kenya, as well as estimated the current GHG emissions and considered appropriate strategies to improve its productivity and environmental impact. Alongside traditional livestock, the potential of aquaculture has also been investigated and scaled up in the country since 2009, yet little is known of its environmental impacts.

Table 8: *Contributing institutional efforts regarding livestock and aquaculture*

Institutions	Projects[23]
Aquacultural Association of Kenya	KAPP - Kenya Agricultural Productivity Program (Aquaculture Value Chain, new technologies)
National Aquaculture Research, Development and Training Centre (NARDTC)	KAPP (Aquaculture Value Chain, new technologies)
Food and Agriculture Organization (FAO)	FAO Mitigation of Climate Change in Agriculture (MICCA) Programme with the World Agroforestry Centre (ICRAF) and the East African Dairy Development Program in Kaptumo
World Agroforestry Centre	Partnerships for scaling CSA (ICRAF-CIAT) EC-Low Emission Development
East African Dairy Development	Agricultural Sector Development Support Program (cow, milk aquaculture value chain platform), natural resource management, climate change with a view to mitigation, social inclusively.
International Livestock Research Institute (ILRI)	ILRI-ICRAF-CIFOR program on mitigation
Kenya Agricultural and Livestock Research Organization (KALRO)	Cassava Dairy Feeds – KALRO
National Aquaculture Research and Development and Training Center	A case study in Aquaculture Practices
KALRO (Katumani and Embu)	Improvement of Dairy Productivity and Marketing in Sub-humid and Pastoral Areas of Kenya through Improved Dairy Value Chain

[23] See the supplementary material to this report for more detail

Table 9: *Overview of key activities, results and recommendations regarding livestock and aquaculture*

Key Activities	**Results**
• Estimating emissions accounting for multi-functionality of small integrated systems • Emissions were estimated for dairy farming households in the Rift Valley • Evaluating mitigation potential of manure management • Improved feed management practices, evaluating potential of replacing maize with cassava in feeds • Evaluate feasibility and support expansion of aquaculture	• Emissions accounting for multiple functions change the valuation of livestock activities • Opportunities for dairying to be regarded as CSA when evaluated in a whole-farm system as relatively climate-neutral • Management needs improvement at all stages of manure management. Collection stage especially difficult due to extensive grazing • Diet improvements and the combination of diet and manure management have potential for changes in both GHG reduction and increases in productivity, but their adoption potential remains low • Aquaculture activities obtain high yields, contribute positively to incomes, and provide potential for synergies with broader agricultural systems
Recommendations	
• Need full value chain and whole-farm integrated approaches to identify best climate-smart livestock and aquaculture opportunities • Incentives are needed so that improved manure management practices become viable options • Climate-smart activities must extend beyond technologies to include institutions and capacities; there is therefore a need to continually build awareness, capacity and exposure *Further research:* • Aquaculture needs additional research in postharvest handling, new and improved breeds and fish feed • Improve estimations of emissions factors from livestock and aquaculture • Improve assessments for the calculation of the real value of cattle in multifunctional smallholder systems • Improve understanding of the heterogeneity of household resources • Need to understand incentives to intensify inputs- especially feeds	

4.3.2 Activities

ILRI explored how to account for multi-functionality within the Life Cycle Assessment (LCA) method in a case of smallholder milk production in Kaptumo area in Kenya. LCA is an acknowledged method to assess the contribution of livestock production to GHG emissions of livestock, to marketable outputs. However, smallholder systems provide several products and services besides the production of marketable products, a feature that must be accounted for in LCA assessments to achieve results representative of these systems.

Under FAO's Mitigation of Climate Change in Agriculture (MICCA) programme, baseline emissions were estimated for dairy farming households in the Rift Valley. The project quantified the emissions from all livestock raising activities in Kenya, including CH_4, N_2O (nitrous oxide) and CO_2 emissions from enteric fermentation, manure and feed management sources. Opportunities for GHG mitigation were identified with the intention that results will inform the process of developing a certified methodology to link productivity gains to a reduction in GHG emission intensity. Project results will help identify the appropriate support mechanism and will inform national policies on future livestock sector development as well as policies addressing climate change. The MICCA pilot project also compared the greenhouse gas balances from three farms across an intensification gradient (grazing, semi-zero grazing and zero grazing) using default values for nutrient stock and GHG fluxes. Results were also compared against measured values.

Another ILRI project looked into the mitigation options through manure management. The project analyzed current manure management practices to identify nitrogen use efficiency and potential areas for improvement. The project investigated nitrogen leaching in the soil under different practices: beneath open air heaps and pits with maize stover; in a control heap of pure manure without mixing with maize stover; and in a control soil adjacent to the experiment.

KALRO activities explored the potential of improved livestock management practices by improving feed. The project sought to address the challenges in feed production, disease management, processing and marketing, along the camel, goat and cattle dairy value chains, in order to improve livelihoods and catalyze economic growth in Embu, Kiambu, Makueni, Meru and Nyeri Counties. The project started with background and contextual research that identified constraints and potential interventions and led to the testing of different ingredients and compositions for feed formulas. Results gave rise to the potential substitution of high cost maize meal with cassava meal in high quality dairy feed formula. The project tested the replacement of maize meal with cassava meal at varying rates of 25%, 50%, 75% and 100%. As the next stage of the project, 20 tons of feed will be produced to conduct on farm trials among 10,000 Kiambaa Dairy Rural SACCO farmers. Meanwhile, demonstration plots were established with a range of elite cassava cultivars with varying results in different agro-ecological zones and dry chips and flour traders have been identified. The project recommends the increased distribution of promising cultivars in their appropriate zones in order to increase the supply of cassava chips and flour for the production of cassava-based dairy meal. A cassava policy and development strategy for scaling up the initiative in Kenya has been prepared.

The National Aquaculture Research and Development and Training Centre supports the rise of aquaculture activities by investigating its potential through a mapping of existing sites in Kenya, as well as piloting aquaculture farms. Aquaculture has seen large increases since 2009: the number of fish farmers undertaking tilapia and catfish farming improved to over 70,000, as brought about by the construction of over 69194 ponds under the Economic Stimulus Program, with an area of 20,758,200m^2 (2,076 hectares), 161 tanks measuring 23,085m^2 and 124 reservoirs with an area of 744,000m^2 throughout the country. The number of hatcheries also increased from 8 to 150, while four fish processing plants were constructed in the Tetu, Imenti South, Rongo and Lurambi constituencies.

4.3.3 Overview of results

In analyzing the various components of a smallholder LCA, Kenyan experts were not able to definitively identify a viable low-carbon development option that would allow the dairy industry to grow and simultaneously limit emissions. However, diet improvements and the combination of diet and manure management have some potential for changes in both GHG reduction and increases in productivity, but their adoption potential remains low. Experts and stakeholders noted strong barriers to action in the livestock sector. Constraints include the cultural and economic importance of cattle and resistance to change in rural communities. Nonetheless, efficiency gains in dairy production provide the opportunity to achieve multiple goals: food security, income and livelihood benefits, environmental benefits and improved resilience to climate change. The MICCA findings demonstrate that livestock is only 16-40% of the on-farm GHG budget. Because many of the climate impacts from livestock in poly-cultural systems can be offset by agroforestry, improved feeding practices, and improved pasture management, dairying can be relatively climate-neutral when considered in a whole-farm system, and evaluating it in this way provides opportunities for its regard as CSA.

Manure management is a possible option for mitigation, but farmers may not always be interested in taking the necessary measures, as there is no immediate added value to be gained from adopting them. Therefore, incentives may be needed so that improved manure management practices become viable for farmers. Despite being sometimes overlooked, the case for improved manure management is a strong one. Experimentation has shown that crops do not respond to mineral fertilizers when the content of organic matter (OM) in the soil is very low, and therefore local soils require OM to sustain adequate levels of production. There are competing uses for the organic resources: they are needed to feed livestock, while their removal has negative consequences for soil OM and yields. Meanwhile it takes a number of years to reap the benefits of manure applications[24]. An African level assessment shows that estimated current amounts of N available throughout Africa are relatively limited and are concentrated around few places. However, a large potential exists to increase this availability through crop-livestock integration. In extensive systems, characteristic of much of smallholder African farming, feeding practices constrain nitrogen recycling on the farm, because livestock often grazes over large distances making collection impossible, and the only manure that is usually recycled is that which is deposited on-farm during confinement. Farmers that make the change to more stationary feeding may be interested and benefit the most from good management of the manure, while poorer farmers are unable to collect sufficient manure due to extensive grazing. The seasonal differences in feed management strategies (dry season vs. rainy season) may also have important consequences for manure management. In Western Kenya, livestock is grazed off farm in a more extensive feed management style during the wet season than during the dry season and, therefore, the concentration of livestock feeding in the dry season provides better opportunities for manure collection. Leaving manure in enclosures for longer time periods results in losses of nutrient value, while making heaps improves the fertilizer value.

Crop-livestock systems vary in their management and consequently have a wide range of nutrient cycling efficiencies (the ratio of useful output to input for each subsystem). Management needs improvement at all stages of manure management to ensure highest efficiency, from manure collection, to storage, to soil and crop uptake[25]. Simple

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[24] Tittonell, P., Corbeels, M., van Wijk, B., Vanlauwe, B. and Giller, K.E. 2008. Combining Organic and Mineral Fertilizers for Integrated Soil Fertility Management in Smallholder Farming Systems of Kenya: Explorations Using the Crop-Soil Model FIELD. *Agronomy*, 100: 1511 - 1526.

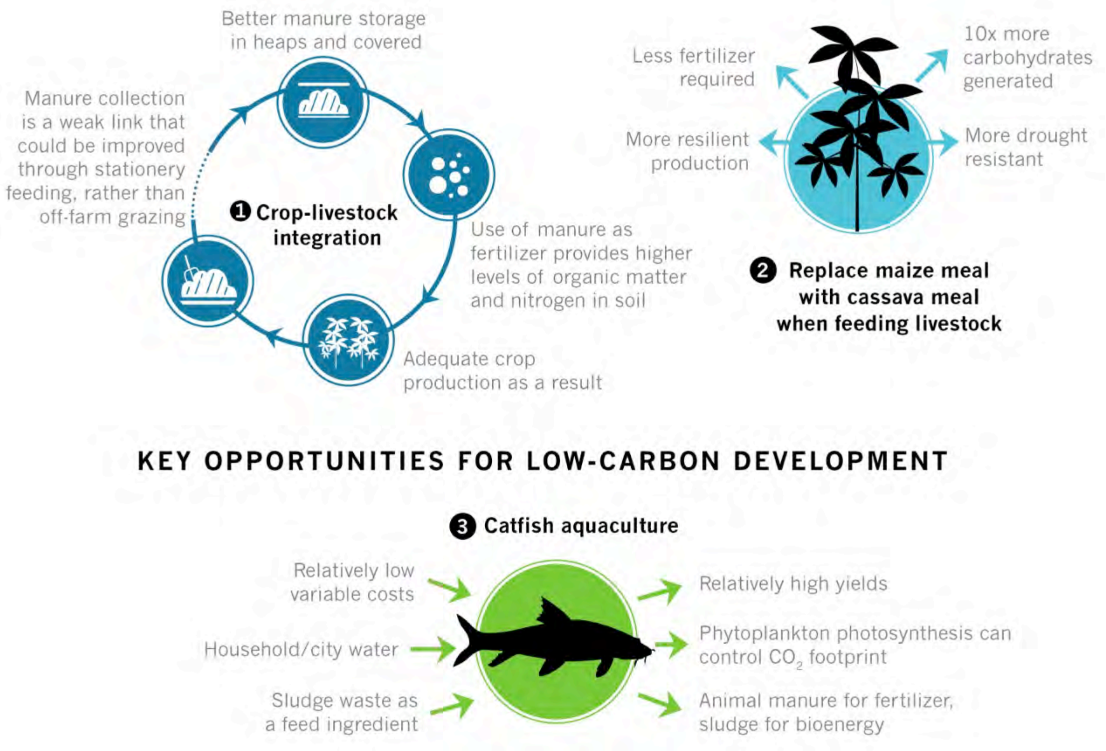
[25] Rufino M. C., Rowe E. C., R Delve. J. and Giller K. E., 2006. Nitrogen Cycling Efficiencies through Resource-Poor African Crop-Livestock Systems. *Agriculture, Ecosystems and Environment* 112 (4): 261-282.

practices such as covering manure can greatly improve N use. The weakest link in management is the collection stage.

Replacing maize meal with cassava meal in the feed formulas and establishing the product in the market is expected to increase profitability of both cassava production and livestock raised on cassava-based feed. The increased demand is expected to spur farmers' decisions to increase production of the crop - particularly in ASALs, which comprise 75% of Kenya. The use of cassava as a source of carbohydrates in feeds would have multiple monetary and environmental benefits. Cassava produces 10 times more carbohydrates than most cereal crops per unit area, time and inputs, and is more resistant to drought and limited fertility than its maize alternative. Its grounded nature provides an opportunity for better-adapted and more resilient production in drought prone and marginal areas as well as a chance to decrease reliance on fertilizer. Maize requires ten times the amount of fertilizer to produce the same yields. Replacing maize with carbohydrates will also result in reduced emissions from fertilizer production and transport due to lower demand.

Findings show that catfish aquaculture has the potential to increase food security while integrating with other farm activities. A case study on the feasibility of catfish aquaculture in Kenya showed that relatively high yields of 530kg per year, with relatively low variable costs, could be obtained. Aquaculture produced 13,501 metric tons of product in 2013. Additionally, the system can make use of harvested or city water. Sludge waste can also be incorporated as a feed ingredient for fish limiting waste accumulation. Harvesting the potential of phytoplankton photosynthesis can be beneficial for controlling the CO_2 footprint, and the reuse of animal manure for fertilizer and sludge for bioenergy allows for synergies with the broader production system. Aquaculture is dependent on carbon sources, however, including the direct use of fossil fuels for production activities, the conversion of natural ecosystems or agricultural land into aquaculture farms and stock respiration and waste decomposition (accumulated faeces and uneaten feed become sources of environmental pollution).

Figure 7: *Key opportunities for low-carbon development*

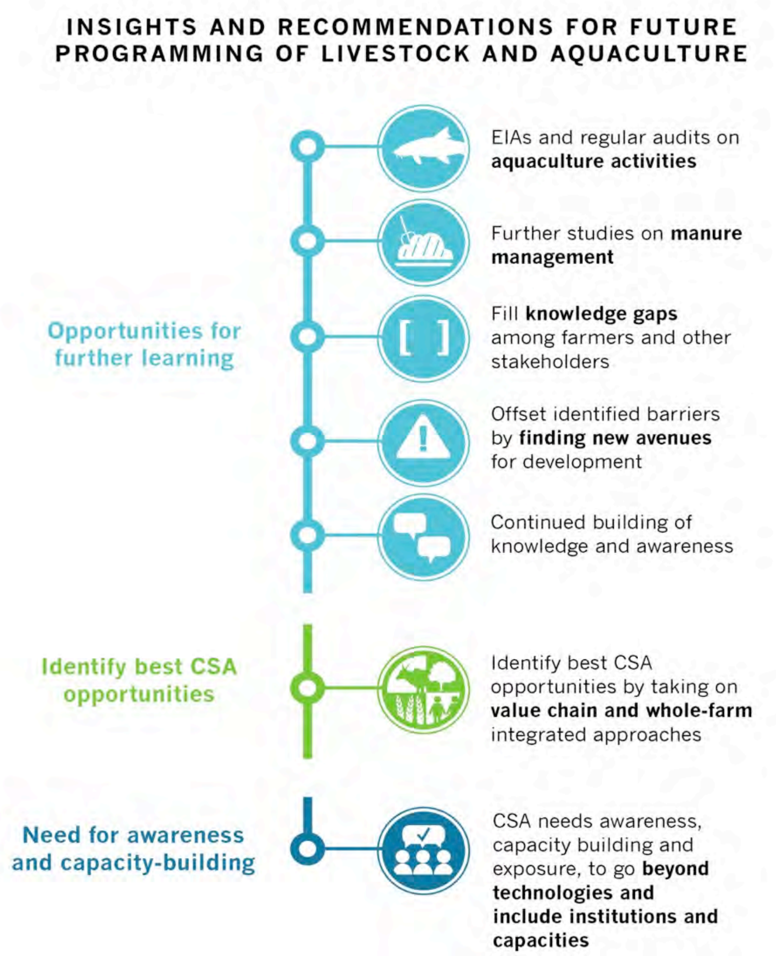


4.3.4 Insights and recommendations for future programming of livestock and aquaculture

- There is a need to take on value chain and whole-farm integrated approaches to identify best climate-smart livestock and aquaculture opportunities.
- Climate-smart approaches need to extend beyond technologies and includes institutions and capacities. It therefore needs awareness, capacity building and exposure.
- Despite the sensitivity and complexity of semi-arid Kenyan livestock sector to introduced mitigation measures, continued building of knowledge and awareness is important to lay the groundwork for the future.
- Barriers identified can be offset by identifying new avenues for financing livestock development, providing methodology for MRV, investing to support technology transfer and uptake, and by building a strong link between proposed, pilot and NAMAs.
- Manure management for mitigation must be studied further, questions remain on how to proceed, including where to measure emissions in different livestock systems, which unit of emissions to use (per head/per ha) and how to promote improved manure management practices in such varying livestock management systems.

- Considering its rather recent scale-up in Kenya, an Environmental Impact Assessment (EIA) and regular audits of aquaculture activities must be completed. More research is needed to fill information gaps in both livestock and aquaculture research, with the following topics identified for further research: small scale low tech postharvest handling of fish, improving breeds of tilapia and catfish, domesticating other fish species, understanding and quantifying emissions factors from livestock and aquaculture, assessing the real value of cattle in multifunctional smallholder systems, adapting the feed base of cattle and fish, the heterogeneity of household resources and understanding the incentives to intensifying inputs - especially feeds.
- There is a need to fill knowledge gaps among farmers and other stakeholders, including: training in marketing, inputs supply, information sharing on aquaculture, biogas in smallholder less intensive system, strengthening institutions, facilitating access to credit facilities, and assisting in regulation and policy.

Figure 8: *Recommendations for future programming; livestock and aquaculture*



4.4 Energy: cook stoves, biogas, briquettes

Authors: Peter Malomba (Kenya Cookstoves Association), Mary Njenga (ICRAF), Miyuki Iiyama (ICRAF), Kenda Mwenja (GIZ), Daniel Gichuhi (KENAFF)

4.4.1 Background

Approximately 68% of Kenyans in both rural and peri-urban areas use firewood for heating and cooking. This practice puts pressure on locally available wood resources and results in indoor air pollution that leads to many detrimental health effects. Institutions evaluated alternative methods for improving the efficacy of household energy consumption: improved cook stoves, briquette production and biogenerators. No findings were presented regarding solar energy sources, as relevant project partners were not able to attend the workshop.

Improved cook stoves are environmentally friendly as well as socio-economically more sustainable; they are designed to maximize the use of biomass, reduce air pollution and sometimes provide additional by-products, such as biochar. The stoves are affordable, made from local materials and easy to maintain. The gasifier cook stove saves 40% and 30% of fuel and cooking time respectively when used in a traditional three stone stove, and yields 20% charcoal. Carbon monoxide (CO) and particulate matter (PM2.5) pollution from the gasifier stove is 45% and 90% lower than the traditional three stone stove. Benefits include additional fuel for cooking and income and employment generating possibilities. Charcoal produced by the gasifier stove is 9 and 15 times cheaper than lump charcoal and kerosene respectively. Additionally, it burns for longer (4 hours versus 2.5 of lump charcoal) and produces 3 times less carbon monoxide and 9 times less fine particulate matter than lump charcoal. The increased cook stove efficiency has a larger scale potential to conserve forests than the traditional 3 stone stove.

The savings gained from the use of the stove can be channelled towards farm inputs, education or health. Improved cook stoves reduce both internal and external air pollution in the environment; by reducing kitchen smoke they reduce chest and eye ailments for mothers and children. They are easy to use and reduce burns and fires. Cook stoves also provide additional social benefits, such as reduced cooking time and lower firewood collection frequencies, which allows more time for the women to attend to other family chores and frees up time for the children to concentrate on schoolwork.

Biogas systems also form a cost-effectives and environmentally friendly alternative to firewood for heating and cooking. They were first installed in Kenya in the 1950s to make use of coffee waste. In the 1980s, GTZ promoted the floating drum technology that utilized dung, but by 2005 had switched to promoting the fixed drum design as an add-on to dairy farming.

Table 10: *Contributing institutional efforts regarding energy*

Institutions	Projects[26]
Improved Stoves Association of Kenya (ISAK)	Improved stoves
KENAFF (Kenya National Farmers Federation)	
SNV Kenya (Netherlands Development Organization)	
EnDev/GIZ	Solar energy and cookstove projects
SLU - Swedish University of Agricultural Sciences	Woodfuel innovations for sustainable livelihoods and environment
ICRAF - World Agroforestry Centre	Woodfuel innovations for sustainable livelihoods and environment
IITA - Institute of Tropical Agriculture	Woodfuel innovations for sustainable livelihoods and environment

Table 11: *Overview of key activities, results and recommendations regarding energy*

Key Activities	Results
• Promotion of improved cook stoves • Promotion of efficient use of biomass residuals • Promotion for increasing use of domestic biogas units • Capacity building among construction companies and artisans to install new biogas units • Support for local production of briquette technology • Solar	*Adaptation* • Increased access to sustainable organic fertilizer inputs (slurry by-product from biogas units) to increase soil carbon • Decreased pressure on forest biomass resources (each cooking stove has capacity to save 1.09 tons of firewood annually) • Access to readily available, convenient, cheaper energy (biogas, biomass residuals) *Health and livelihoods* • Improved health by decreasing indoor air pollution • Reduced burden on women and children for fuel-wood collection (improves availability of labor) • Time saved in cooking and firewood collection, creating time for other productive activities • Increased household incomes • Employment opportunities created *Mitigation potential* • Decreased GHG emissions. GHG reduction is estimated at

[26] See the supplementary material to this report for more details

	19,500 tons of CO_2 equivalents annually from biogas project. • Saves trees hence regulating, supporting and provisioning ecosystem services by trees
Recommendations	
Create a conducive environment: • Holistic approach to energy issues (farming system, landscape, national etc.) • Extension and technology know how is still limited • Financial (credit) – procurement of technology • Engagement at county level • Multi-sectoral and multi-stakeholder engagement at county and national level *Integration of renewable energy issues in climate change policies* • Establish quality standards, regulations and enforcement • Address inconsistencies between policies and regulations (e.g. charcoal making is illegal while usage is legal) • Address education and extension capacities *Capacity building:* • Increase the understanding the multi-dimensional needs of users (e.g. cultural) and farming systems • Increase awareness levels among potential users *Need for further research:* • Evidence of climate mitigation impacts in larger value chains (wider socio-economic contexts) • Applicability of biogas in different farming systems (confined livestock production) • Capacity to adapt biogas technology to other organic wastes • Energy use efficiency of various improved cooks and fuel briquette types using different feedstock towards sustainable bioenergy • Support research to improve evidence of energy interventions and continue with innovations while documenting and sharing impact lessons (livelihoods, mitigation impacts, health, etc.)	

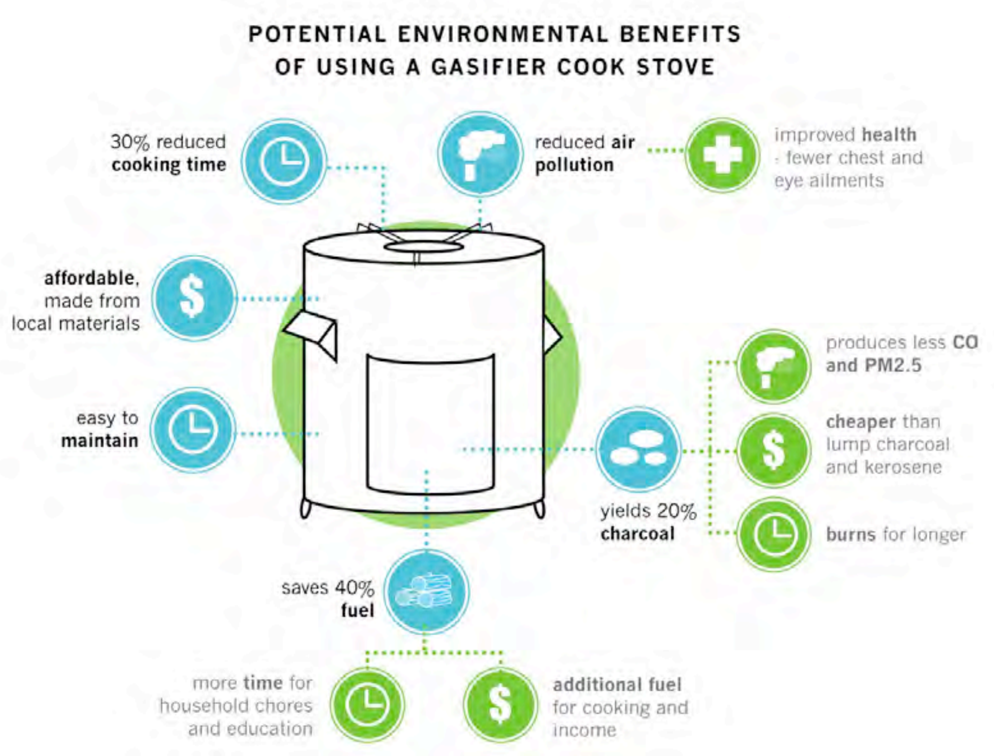
4.4.2 Activities

A demand survey indicated a potential need for more than 100,000 biogas units and, with funding from the European Union, GTZ/GIZ was able to scale up their biogas project. They built capacity among construction companies and artisans who could install units and reached out to create awareness among end-users/consumers, extension agencies and the financial sector regarding gas production and use, and slurry use for increased agricultural productivity. Awareness campaigns also stressed the need to feed dung into the bio-generator as an incentive for better livestock management, and created linkages to financing to enable the projects.

The Woodfuel Innovations for Sustainable Livelihoods and Environment project promoted community-based briquette production (including sourcing biomass raw materials, pressing, drying and selling of fuel briquettes) and improved gasifier stove cooking technology. Improved gasifier cook stoves burn fuel under controlled oxygen and release gases; the process enables achieving high cooking temperatures, while producing charcoal as a by-product.

Originally formed by GTZ/PSDA (Promotion of Private Sector Development in Agriculture), the Improved Stoves Association of Kenya (ISAK) works to expand cook stove activities. They create links amongst members, stakeholders and development partners; engage government in developing biomass policies regulations and standards that will enhance promotion and use of improved cook stoves; promote and market modern improved and efficient cook stoves, technologies and solar equipment; and enforce standards. They work in 29 counties in Western, Central Rift Valley, Nyanza and Eastern Kenya. ISAK promotes six types of different cook stoves: the brick rocket stove, *jiko kisasa*, institutional stove, basket fireless cooker, firewood baking oven and the cladded multipurpose jiko stove.

Figure 9*: Environmental benefits of using an energy-efficient, gasifier cook stove*



4.4.3 Overview of results

The biogas, cook stove and briquette initiatives have had important environmental and socio-economic impacts. They have decreased pressure on forest biomass resources, increased access to sustainable organic fertilizer inputs, improved availability of labor, improved health by decreasing indoor air pollution, decreased GHG emissions, increased household incomes and created employment opportunities.

Since 2010, KENDIP/KENFAP/SNV have installed more than 12,000 biogas units. Under the project more than 300 artisans have been trained and 26 biogas businesses established. Between 2008-2011, the project strengthened the capacity of 300 artisan plant constructors and helped to establish more than 26 biodigester companies. The result of this capacity building effort was the installation of more than 800 smallholder biogas plants. The impact of the project includes providing more sustainable access to energy and agricultural inputs while ensuring reduced spending in the long term. The investment cost per biodigester has a payback period of 2-3 years due to its by-products of fuel and slurry, which replace the need for firewood and fertilizer. Overall, project savings of 10,600 tons of fuel-wood (at an energy mix of 73% wood and 27% charcoal) equal an annual saving of 67 ha of forest, due to reduced resource pressure. The project also promoted a reduced reliance on inorganic fertilizer due to the high quality agricultural slurry by-product of biodigesters. Overall GHG reduction is estimated at 19,500 tons of CO_2 equivalents annually. The installation of biodigester systems is also accompanied by a series of social benefits, such as, reduced indoor air pollution from cooking, and saving households on fuel-wood collection time. Biodigesters also have potential secondary impacts at the national scale, including; improved soil health, forest conservation, reduced emissions and decreased reliance on fertilizers and fossil fuels. Nationally, more than 15,000 domestic biogas systems have been installed.

Between 2007 and 2014, 189,280 households accessed and installed improved cook stoves. Each stove has the capacity to save 1.09 tons of firewood annually in Bungoma County, which is equivalent to 11.336 ha of regional forest savings, and the stoves reduce 13,629 tons of CO_2 annually. Approximately 180-200 people are gainfully employed in stove activities. Countrywide, there are now more than 1.5 million in Kenya using improved cook stoves. The industry has created jobs for skilled installers of cook stoves (with more than 1,100 installers in the market) and spurred the development of stove enterprises (production centers for liners). The launch of the alternative business industry related to these activities is creating skilled jobs both in rural areas and urban settings.

4.4.4 Insights and recommendations for future programming

Initiatives identified the following important recommendations and knowledge gaps for continued work on household energy efficiency for creation of an enabling environment, for capacity development and further research.

Create a broader enabling environment:

- Holistic approach to energy issues (farming system, landscape, national etc.)
- Extension and technology know-how is still limited
- Financial (credit) – procurement of technology
- Engagement at county level
- Integration of renewable energy issues in climate change policies
- Establish quality standards, regulations and enforcement
- Address potential inconsistencies between policies, regulations and implementation (The new Forest Act will provide for charcoal burning on a sustainable basis to stop forest destruction and ensure constant supply to fuel to families who cannot afford alternatives)
- Address education and extension capacities

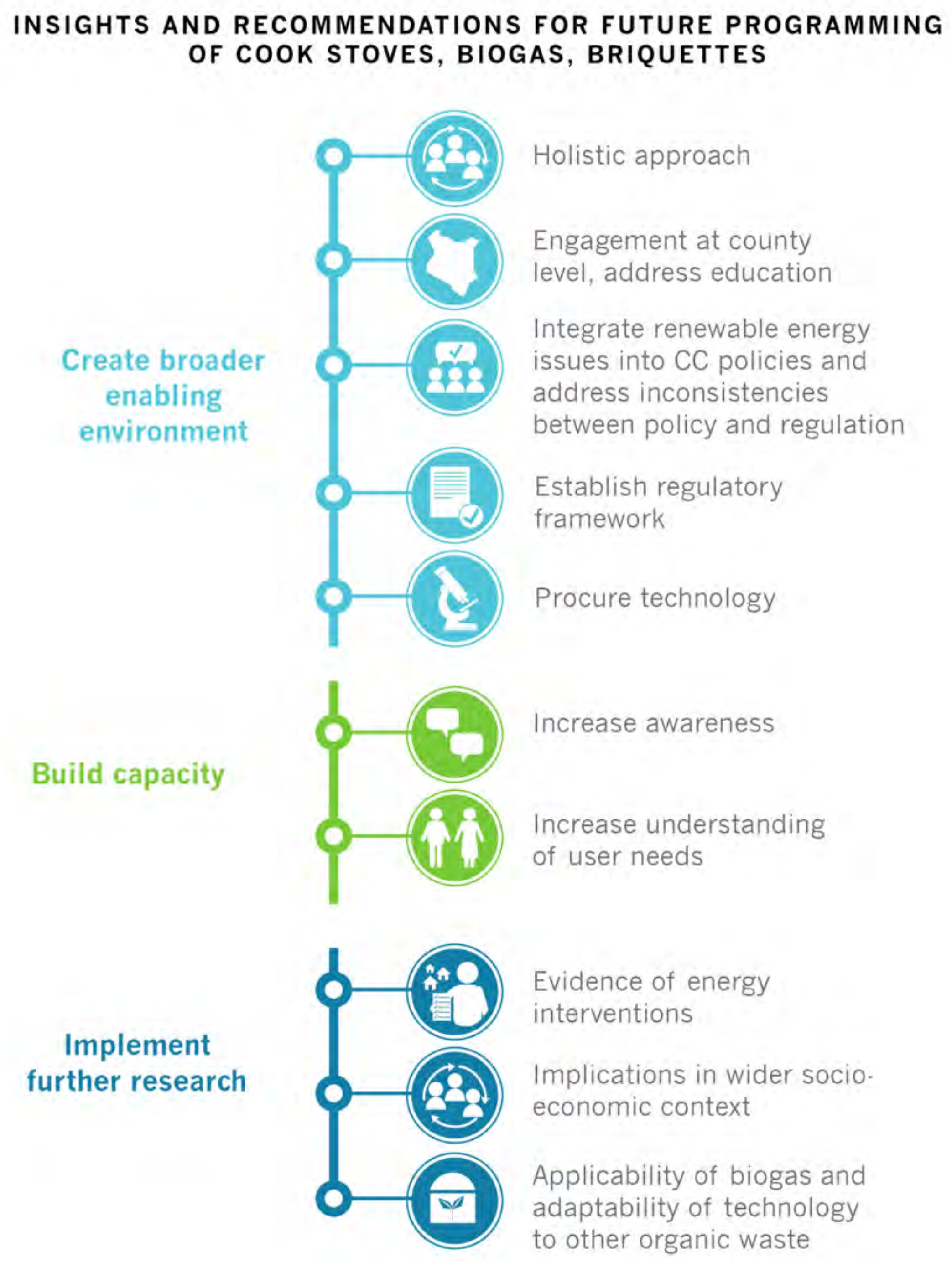
Capacity development:

- Increase the understanding the multi-dimensional needs of users (e.g. cultural) and farming systems
- Increase awareness levels among potential users

Need for further research:

- Evidence of climate change mitigation impacts in larger value chains (wider socio-economic contexts)
- Applicability of biogas in different farming systems (confined livestock production)
- Capacity to adapt biogas technology to other organic wastes
- Support research to improve evidence of energy interventions (livelihoods, mitigation impacts, health, etc.)

Figure 10: *Insights and recommendations*



4.5. Conservation agriculture and agroforestry

Authors: Nasirembe Wanjala (Egerton University), Ermias Betemariam (ICRAF), Richard Biwott (DFBA), Moses Karanja (EADD/ICRAF), Christine Lamanna (ICRAF), Oscar Masika (ICRAF), Beatrice Mnede (WorldVision), Joseph Mumu (ALF), Matthew Murhor (EADD), Sylvia Nanjekho (ICRAF), Barrack Okoba (FAO), Joan Sang (World Vision), Emmanuel Wachiye (ViAgro), Leigh Winowiecki (CIAT), Jonathan Muriuki (ICRAF)

4.5.1 Background

Climate change and variability are major challenges facing smallholder farmers, livestock keepers, and fishermen and women; especially those residing in fragile environments where they are directly exposed to the risks associated with climate change. This is particularly true in regions that already suffer from soil degradation, water scarcity and high exposure to climatic extremes, and where poverty and hunger persist. Around 20% of Kenya's landmass is suitable for rain-fed agriculture[27]. However, much of it has been adversely affected by the temporal and spatial variability of rainfall, in addition to declining soil fertility, resulting in water deficits during critical stages of crop growth. Even in cases of adequate annual rainfall, climate variability and land degradation have negatively affected crop yields. Conventional approaches towards crop production have not resulted in sustained food security for smallholders. In response, research on the feasibility of conservation agriculture (CA) in Kenya has focused on the following objectives: 1) improving maintenance of these key challenges; 2) increasing water holding capacity; 3) increasing farmer system resilience and food production, 4) increasing soil carbon and 5) preventing land degradation.

[27] NEMA. 2010. 20 percent - National Environment Management Authority

Table 12: *Contributing institutional efforts regarding conservation agriculture and agroforestry*

Institutions	**Projects**[28]
ICRAF	Conservation agriculture and agroforestry practices for improved nutrition, household income & landscape health in ESAF
FAO-ICRAF/MICCA	MICCA pilot projects: Is conservation agriculture also climate-smart? Targeting CA based on sites. Baselines for Mitigation of Climate Change in Agriculture
CIAT	IFAD project on increasing food security and farming system resilience through wide scale adoption of CSA
CIAT	Playing out transformative adaptation in CCAFS benchmark sites in east Africa: 'when, where, how and with whom?'
Vi Agroforestry	Sustainable agriculture land management practices (SALMs) or CSA for increased farm productivity, Food security and climate resilience.
World Vision	Farmer Managed Natural Regeneration Rain Water Harvesting/Conservation Agriculture
KALRO	Enhancing Soil and Water Management Strategies in small-scale wheat farming The effect of tillage on moisture retention in soils: A case study of volcanic soils of Eastern Mau, Kenya.
Dairy Farmers Business Association (DFBA)	Bulking and Marketing of Milk within Dairy Value Chains
FAO	Climate change adaptation through soil and water management and strengthening capacity
FAO-Kenya	Adapting to climate change using CSA-based technologies
Tree Farmers Association of Kenya	Improvement of livelihoods of New Settlers (IDPs)

Table 13: *Overview of key activities, results and recommendations regarding conservation agriculture and agroforestry*

Key Activities	**Results**
• Field trials and promotion of conservation agriculture (CA) • Practices considered: tilling, tree planting, terracing, water harvesting and management, residue management, tree regeneration • Combinations of sustainable land use practices investigated • Site research conducted to understand local context for	• Conservation Agriculture with Trees (CAWT) increases soil moisture and increases agricultural yields • CAWT also reduced labor, reduced inputs, fodder, firewood, fruit, other economic benefits • Healthy soil increases farmer self-sufficiency • Farmers are more likely to diversify their farming systems when they have healthier soil and lower land degradation status • CSA must be site and farming specific (terraces work on large farms, zai pits work on small farms)

[28] See the supplementary material to this report for more details

<table>
<tr>
<td>implementation
• Action research
• Estimating site-specific likely outcomes of CA through modelling
• Training in CA practices
• Linking land health and socio-economic data to assess the barriers and opportunities for CSA across diverse landscapes</td>
<td>• CA is not instantaneous. Results take time to be visible, soils take a while to recover
• Land health, food security and economic aspects of livelihoods are inextricably linked</td>
</tr>
<tr>
<th colspan="2">Recommendations</th>
</tr>
<tr>
<td colspan="2">• Farmers should pilot CA projects, CA adoption must be a learning process
• Develop support, extension & farmer training for CA adoption
• Enhance information flow from research to Training of Trainers to farmers
• Enhance information sharing among stakeholders
• Enhance Farmer-to-Farmer extension
• Frequent review of CA best practices and climate info
• Improve accessibility of seeds/seedlings of agroforestry tree species
• Need reliable climate forecasts
• Improve training for farmer facilitators (lack of capacity)
• Interdisciplinary approaches should be utilized to better address the complexity of CSA systems

Further Research:
• Baseline information on measuring CA effectiveness in different farming systems (including environmental, social and economic aspects)
• Complete Costs/benefits of implementing CA to understand how long before benefits are realized
• Role of gender in CA adoption
• Livestock and CA interaction
• Suitable tree species for different farming systems and farm sizes</td>
</tr>
</table>

4.5.2 Activities

CA activities in Kenya include land health monitoring, site-specific research, action research, modelling, agronomic trials, socio-economic household surveys and capacity building. Initiatives considered individual practices such as conservation tillage and tree planting, as well as cases using combinations of sustainable land use practices.

Addressing the complex challenges facing food security, while also acknowledging the impacts of climate change, requires interdisciplinary approaches. The International Center for Tropical Agriculture (CIAT), under the CCAFS CGIAR Research Program, focused on the integration of co-located socio-economic and biophysical datasets collected using systematic baseline survey methods, in order to better understand and develop locally appropriate solutions. Rapid rural assessments (Climate-Smart Agriculture Rapid Appraisal - CSA-RA[29]), household surveys and land health surveys (using the Land Degradation Surveillance Framework - LDSF) were conducted and combined to develop a deeper understanding of the local context in order to scale-out locally appropriate CSA practices. In addition to Kenya, this program was also piloted in the CCFAS climate-smart villages in Tanzania, Uganda and Ethiopia. It connected farmers, National Agricultural Research Institutes, district councils, universities and international research centers such as CGIAR. The project also made links with broader institutional actors, such as the International Fund for Agricultural Development (IFAD), to create parallels with policy initiatives.

As part of the FAO MICCA pilot project in Kenya, a team of researchers at ICRAF, along with the East African Development Program, used the LDSF[30] to characterize the context of a study site in the Kaptumo District of Western Kenya, in order to understand current land use dynamics.

A series of projects in Kenya took on a local focus to test CA practices in context: practices tested were terracing, tillage practices, tree regeneration and combinations of multiples conservation agriculture practices. A historical review of rainfall patterns over the last 30 years conducted by KALRO indicated that average annual rainfall should be enough to sustain a wheat crop in Narok, Kenya, however its distribution and intensity adversely affect crop yield. Therefore, KALRO carried out a preliminary evaluation of soil and water conservation structures and re-forestation impact on livelihoods of smallholder farmers in the area, to determine the potential of these practices in countering the increasingly unreliable and intense periods of rainfall. Four sites were selected for 1-2m vertical terracing trials with established vegetation on the edges and crop yield was recorded between 2010-2013.

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[29] Climate-Smart Agriculture Rapid Appraisal, http://ccafs.cgiar.org/climate-smart-agriculture-rapid-appraisal-csa-ra-prioritization-tool#VNzhvcYz5pw

[30] The LDSF is designed to provide a biophysical baseline at landscape level, and a monitoring and evaluation framework for assessing processes of land degradation and the effectiveness of rehabilitation measures (recovery) over time. http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

Conservation tillage and conservation tillage combined with mulching and other practices were tested in two studies. Along with Egerton University, KALRO also investigated conservation tillage systems on moisture retention on the loamy sand soils of Eastern Mau. The project first characterized the soils and analyzed precipitation trends in the area, then evaluated the changes in moisture retention in varying soil profiles under different tillage systems. Another experiment in the MICCA pilot project in Tanzania (FAO-ICRAF-CARE) provided additional knowledge to determine to what extent conservation agriculture is climate-smart: it tested 4 variations of CA techniques (mulching in rows, no tillage lablab, no tillage with trees and no tillage with fertilizer against conventional tillage controls) to determine differences in yield, rainfall use efficiency and GHG fluxes/intensity.

Additional studies tested a broader spectrum of conservation practices. Farmer groups participated in trials of CA practices on water productivity. On-the-ground CSA land and water management practices were established, tested and disseminated in selected watersheds by a grouping of partners coordinated by FAO and the MALF, INADES (Machakos), CREADIS (Bungoma) and RFDP (Ugunja-Siaya). The project led on-farm testing of CA performance on water productivity and organized demonstrations of seed/crop, fruit-trees and fish farming. A total of 28 farmer groups and over 800 farmers (male and female) across Siaya, Machakos and Bungoma counties were involved.

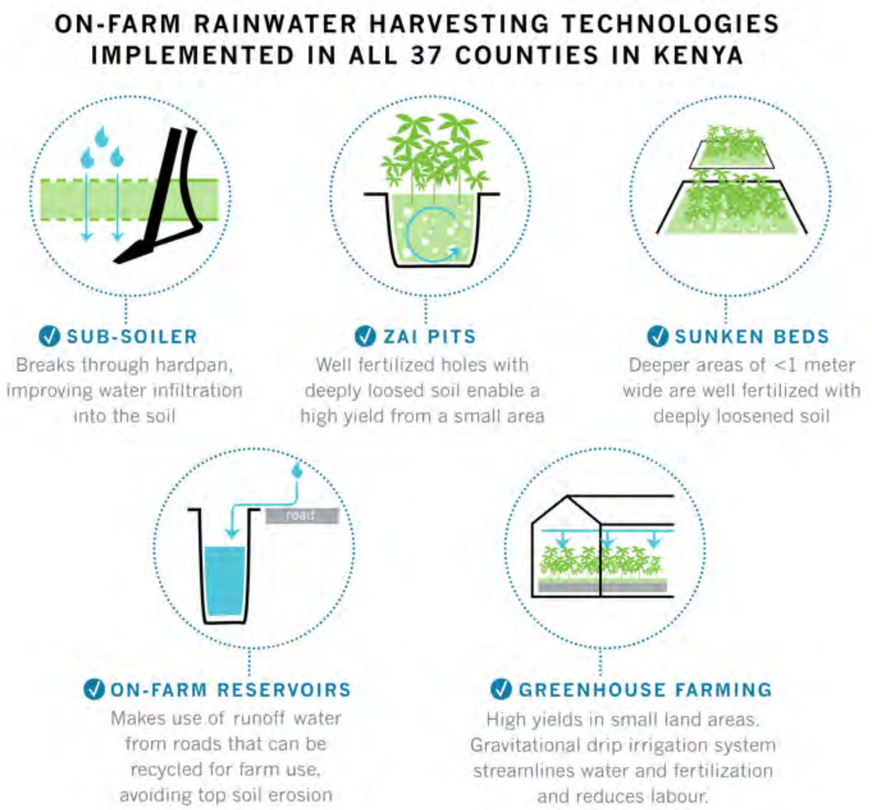
In addition to local CA research efforts, several partners implemented CSA promotional campaigns. The Kenya Agricultural Carbon Project (KACP) implemented by Vi Agroforestry promoted and implemented a package of SALM practices within smallholder farming systems. The goal for KACP is improved agricultural productivity, food security and climate resilience. SALM practices also generate CO_2 removals through soil and tree carbon sequestration. Promoted SALM practices include: soil nutrient management; tillage and residue management; improved agronomic practices; agroforestry; water management and improved livestock management. KACP sets into action monitoring systems, both by project staff and by farmers who record their own data. Both data sets are later compared.

Along with governmental ministries and NGO communities, World Vision promoted the use of on-farm rainwater harvesting technologies (RWHTs) in all 37 counties of Kenya, such as:

- Sub-soilers. Continuous use of the oxen plough has created a hardpan, which impedes water infiltration into the soil, and sub-soiling practices help to break the hardpan and hence improve water infiltration into the soil for use by crops.
- Zai-pits, which are dug holes filled with loose soil and fertilizer or compost which allows intensive planting that gives high yield from a small area.
- Sunken beds, a planting method where deeper areas of no more than 1 meter wide are well fertilized with deeply loosened soil; this land preparation method is suitable for vegetable growing and mostly used for kitchen gardening.
- On-farm reservoirs/barkaads, which make use of runoff water from roads that can be recycled for farm use while avoiding the risk of damage caused by runoff to erosion of topsoil.

Small scale greenhouse farming (with drip irrigation). Greenhouse farming realizes high yields in small land areas, particularly when used in combination with a gravitational drip irrigation system. The method also reduces labor in production by streamlining water application and fertilizer feeding through the gravity fed irrigation system.

Figure 11: *The on-farm rainwater harvesting technologies implemented in all 37 counties in Kenya*



World Vision and the Tree Farmers Association of Kenya (TFAK) worked on promoting the increased integration of tree cover to harness the multifunctional farm benefits of trees, in two different contexts of Kenya. World Vision promoted Farmer Managed Regeneration (FMNR), a systematic re-growth of existing trees or self-sown seeds that can be implemented wherever there are living tree stumps with the ability to re-sprout, or seeds in the soil that can germinate. Living stumps constitute a vast underground forest, however farmers destroy these stumps during land preparation and treat the sprouting stems as weeds, slashing and burning before sowing their food crop. Instead, FMNR trains the farmers on how to survey the farm for existent tree species and then select, prune, and protect them from livestock to promote regeneration.

TFAK promoted reforestation in a complex context with no land ownership rights. It worked with new settlers/formerly internally displaced persons (IDPs) in Molo and Kakuru counties, to provide financial and material assistance to grow trees on their farms and improve their livelihoods. TFAK's approach was to supply fruit and woody seedlings to the new settlers to plant on their homesteads and farms. Their project took place in the Rwangondu, Asinyo and Ikumbi settlements where they set up nurseries and integrated training of tree farming with schools. The project also addressed the unmet sanitation and water shortage needs of the communities by supplying modern toilets and plastic tanks for harvesting purposes.

Factors determining the possibility of scaling up CSA was another topic investigated by the FAO-ICRAF-EADD-CARE partnership, as part of the MICCA pilot projects in Kenya and Tanzania. The group set up a framework and modelling scenarios for using these factors to predict the likelihood of success. The framework identified soil characteristics, slope, precipitation, productivity, inputs, size, tenure, livestock wealth, market linkages and accessibility of information as enabling factors for the success of CA (other soft factors, for which data is missing or not accessible, risk being neglected and thereby reduce the accuracy of the models). Modelling completed was a simple probabilistic model based on literature review values and field assessments of socioeconomic and environmental conditions.

4.5.3 Overview of results

Farms in East Africa with lower soil organic carbon (SOC) values and higher erosion prevalence, are less self sufficient, and on average, rely more on off-farm income. These were the findings of the CIAT-led CCAFS CSA adoption study. Biophysical factors such as soil and landscape health can be constraints that limit management options, and make a strong case for the need for broader adoption of conservation practices that promote overall soil fertility and land health. Results from studies and interventions in Kenya demonstrate the value of conservation agriculture practices in improving soils conservation and water efficiency. Farmers reported practices such as conservation tillage, terracing, water harvesting, agroforestry and improved seed varieties, among others.

The MICCA pilot project also utilized LDSF in Kaptumo, South Nandi County, Western Kenya, in order to assess baseline biophysical constraints. Results showed adequate level of soil organic carbon (above 2%) and exposed a high variation in tree density across the different land uses in the study region. Average semi-natural tree density was quantified at 132 stems ha^{-1}, while cultivated lands had significantly reduced densities of only 45 stems ha^{-1}. Over 45% of land was under crop cultivation with sparse wood cover areas, and generally farms lacked soil and water conservation measures. Moreover, subsoil (20-50 cm) showed lower carbon and total nitrogen values than topsoil (0-20 cm). Overall, approximately 31% of the tested area can be considered under soil degradation risk, considering soil depth restrictions and slope.

Conservation tillage trials showed increases in productivity and soil moisture. Although the effects of conservation practices varied in different years and seasons (short versus long rains), overall CA practices show consistently better results for maize grain yield and rain-use efficiency over conventional tillage, while emitting fewer CO_2 equivalents per ha. Because the CA practice treatments increased agronomic yields, rainfall use efficiency and reduced GHG impacts, these practiced are considered climate-smart.

Different tillage systems tested in Eastern Mau had a significant influence on soil physical characteristics and hence moisture retention in loamy sand soil, to varying extents. A tri-modal rainfall pattern is experienced in Eastern Mau. The probability of getting sufficient rainfall for annual crops was determined to be ≤25%. Physical characteristics that were changed by conventional tillage were reversed, approaching their original characteristics after only eight weeks. Infiltration rates ranked in the order of Minimum Tillage (MT) > Conservation Tillage (CT) > Zero Tillage (ZT) > No Tillage (NT) immediately after the treatments were applied, while the mean moisture retention over the test period was in the order of CT>ZT>NT>MT. Soils with a loamy sand texture retained more soil moisture under CT than the other tillage treatments, most likely due to more particle parking, but the loamy sand soils tested had a low soil water aggregation overall.

Terracing trials in Narok investigated by KALRO showed positive benefits on grain yield in all four-study sites. Visualized results can be seen in the supplementary material to this report. This intervention has been found to increase wheat yield by 88-400%, meaning yield can be increased without increasing acreage. Furthermore, livelihoods of smallholder wheat producers in lower Narok, Kenya, can be further enhanced by a better understanding of predicted rainfall patterns, and by implementing improved soil and water management strategies. While yields in fields without terracing ranged from just over 0.5 t ha^{-1} to just over 1.5 t ha^{-1}, yields in terraced trials ranged from just over 2.5 t ha^{-1} to more than 4 t ha^{-1}.

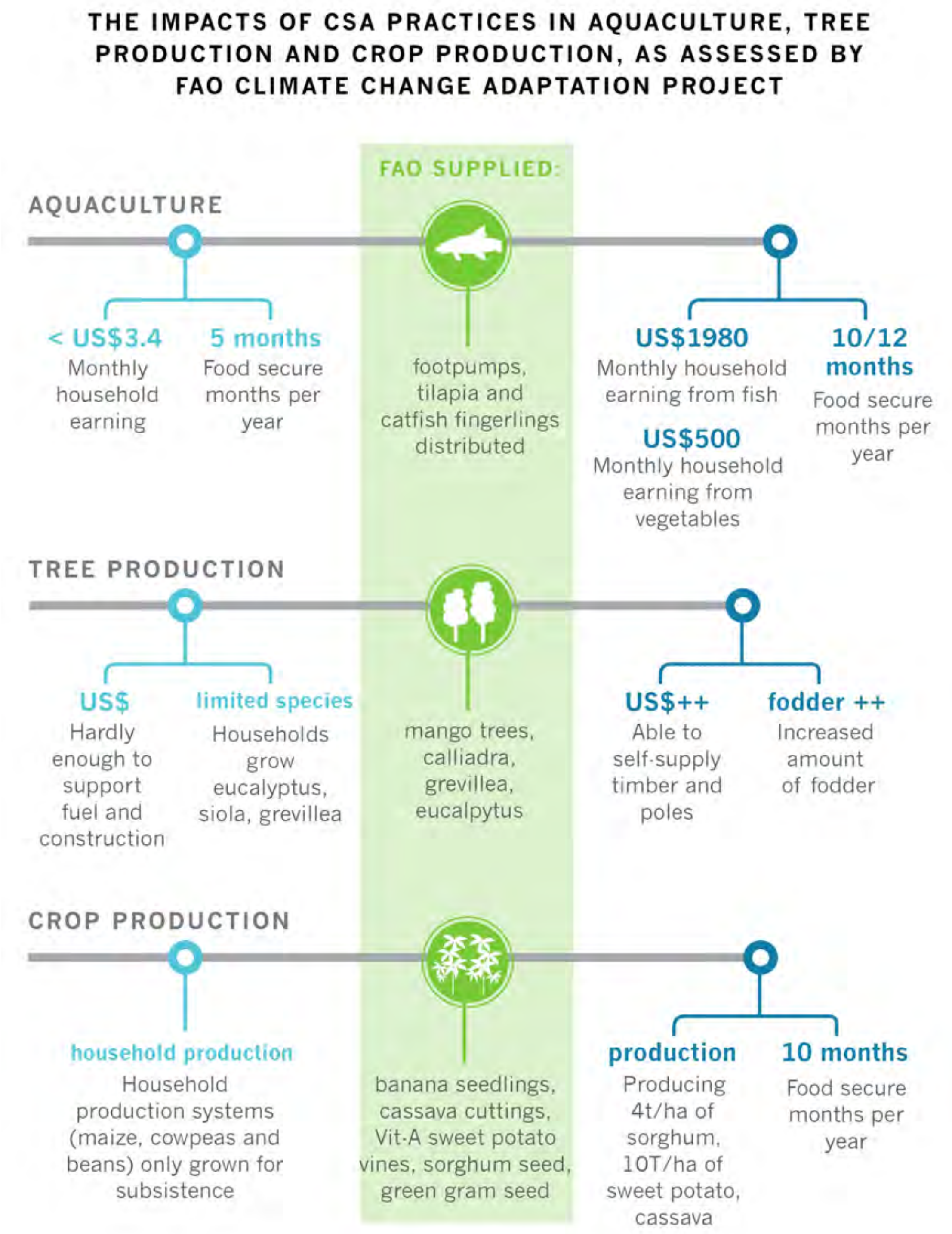
Similarly, a wider selection of CA practices also proved beneficial to yields, soil moisture and incomes. KACP monitoring results show that the 1^{st} season of maize harvests in Bungoma experienced higher yields in farms implementing SALM practices, than among control farmers over the trial years 2009-2012. Farmers adopting SALM practices experienced yields ranging from 1167-2415 kg/ha while control farmers harvested yields ranging from 1023-1578 kg/ha.

FAO findings from the SIDA climate change adaptation project in Siaya, Bungoma and Machakos, indicate that CA-based land manipulation improves yields due to better water storage and resilience to atmospheric and drainage losses. Practice specific results can be seen in the supplementary material to this report. It was observed that ground cover crops influenced more soil-water storage in the sub-soil (>30cm) than tree-shrubs canopy, which pumped soil-water closer to the surface (<10cm). Generally, due to increased SOM levels, P-availability was enhanced under conservation agriculture practices. Moreover cost-benefit analysis conducted on data from Bungoma showed that CA practices tested improved cost efficiency of production as compared to conventional practices.

FAO also assessed the impacts of CSA practices in three sectors: aquaculture, tree production and crop production. FAO distributed several species of fish: 12,000 tilapia fingerlings and

600 catfish fingerlings to 12 farmers in Siaya, along with 50 foot pumps. Activities resulted in improvements to household incomes and food security: incomes rose by 1000% in Siaya on fish and vegetable farming and 200% in Bungoma on vegetable production only. Before the project, households earned <US$ 3.4 per month and were food secure for 5 months out of the year. After the project, households earned US $1,980 per month from the sale of fish, $500 per month from vegetables and were food secure for 10/12 months a year. Activities also diversified cover crop varieties for food and fodder by supplying 2,500 mango trees, 1,800 *Calliandra*, 1,000 *Grevillea* and 800 *Eucalyptus* trees. Prior to the project, households only grew three dominant species (eucalyptus, siola and grevillea) and had hardly enough to support fuel and construction. After the project, 800 Siaya farmers and 2,100 Bungoma farmers were able to self-supply timber/poles and increase the amount of fodder available. Crop production activities provided 3500 bananas seedlings, 1500 cassava cuttings, 300kg of Vita-A sweet potato vines, 180kg of sorghum seed and 60kg of green gram seed to household with production systems only based on maize, cowpeas and beans grown only for subsistence. As a result of the project, 755 households in Siaya and 1500 in Bungoma were using CSA practices and producing 4 t ha^{-1} of sorghum and 10 t ha^{-1} of sweet potatoes/cassava, while staying food secure more than 10 months of the year.

Figure 12: *The impacts of CSA practices in aquaculture, tree production and crop production*



The multifunctional benefits of trees incentivized the scale up of tested agroforestry initiatives in Kenya. Within one year of starting, the FMNR project included over 2000 participating farmers in Nakuru and Baringo counties and resulted in more than 200 acres of reclaimed land. A total of 282 people have adopted alternative income generating activities (IGA) such as bee keeping, poultry farming, rabbit farming and kitchen gardens, in order to divert attention from cutting trees for income. Baringo County has incorporated the concept into their environment and natural resource sector plan. A follow up with Nakuru County was done last year that led to incorporation of the FMNR concept in to their Climate Change Action Plan. Other similar programs are also underway across the country: the Samburu Arid Land Support Program and the Turkana Arid Land Support Program, both in Lokori Area Development Program (ADP). Others include the Integrated Climate Protection and Resource Conservation and the Community Resilience Against Environmental Threats in Lambwe and Karemo ADPs, respectively. FMNR adoption is a challenge where land ownership is not defined or where producers are squatters, since the farmers are not assured of being able to access the eventual pay-offs and therefore hesitant to invest. This scenario has affected uptake in communally owned lands. Use of existing local structures instead of creating others has helped greatly in speeding up acceptance and adoption of FMNR. Farmers' needs are a major influence behind FMNR adoption, for example pastoralists are adopting the concept because it improves their pasture (and the commonly regenerated *Acacia seyal* provides an important source of fodder for animals, especially during dry spells).

Key results of the Tree Farmers Association of Kenya include increased forest cover on cropland, increased availability of wood products along with reduced pressure on government forests, better sanitation and access to clean water and therefore better health conditions, and finally better overall livelihoods due to increased access to other income generating activities, and increased free time for girls to attend school due to reduced time commitments for fetching water and firewood.

The potential benefits of CSA practices do not always result in high adoption rates. A number of constraints were noted to the water harvesting practices promoted by World Vision, namely the high labor demand and longer-term payoffs. The RWHTs being promoted are relatively tedious (e.g. use of the sub-soiler, making zai-pits and sunken beds). Therefore it takes time to change people's attitudes toward CSA practices and often short-term interventions are inadequate to achieve longer-term objectives. However, these technologies are promising for replication in many areas and can achieve strides in productivity and food security if spread over long periods of time.

Locally specific adaptations of CA practices determine adoption as showed by the results of the MICCA pilot project by FAO-ICRAF-CARE-EADD. In place of long durations and high costs of trials, modelling can provide a promising opportunity to estimate potential local success rates of CA or CSA practices. Results modelling the outcomes of CA in four different sites showed that the yield increases in the tested sites of Kaptumo and Kolero are rather unlikely, despite the prognosis that CA tends to result in yield increases in ideal conditions; local conditions determine site specific success rates. The factors that determine CSA performance vary by site; while livestock pressure held more significance in Kolero, market access influenced the likelihood of its success more heavily in Kaptumo. Additional unknown factors may make estimated results less certain, however, overall the site results for Kaptumo leaned considerably towards negative impacts on yield. The study thus concludes that targeting climate-smart interventions with simple models and location-specific data may be a cost effective way to predict project performance and risks *ex ante*.

4.5.4 Insights and recommendations for future programming

Combine interdisciplinary methods to evaluate and develop locally appropriate CSA practices:

- Farming systems and communities are complex and therefore multi-scale, interdisciplinary approaches are needed to address environmental, social and economic realities.
- Soil and land health factors both influence the likelihood of farmers to adopt land management strategies (e.g., CSA technologies) as well as influence the likelihood that the strategy will increase agricultural productivity.

Maintain long-term vision:

- Benefits of CSA are not always observed immediately and a long-term perspective is needed.
- Ensure long term funding for attitudes/behavior change requiring CSA practices.
- Consider labor and gender requirements
- Remain sensitive to the labor and gender demand changes of CSA technologies.

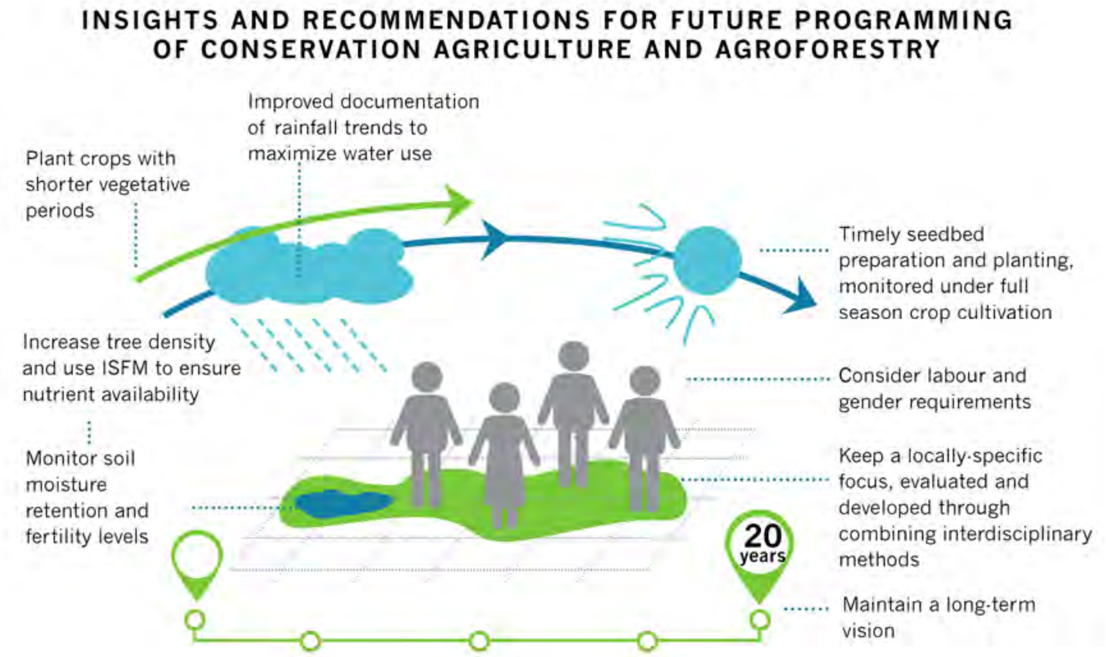
Locally specific focus:

- FAO recommends enhancing adoption of CSA practices that fit in smallholder systems, and increasing the scope beyond crops, continuing to diversify systems to build resistance to climate shocks. Targeting special groups that are vulnerable due to HIV/AIDs, old age/orphans/widows is critical when working with ordinary farmer groups. Additionally, FAO states that it is important to invest in enhanced soil health and conservation of water, and income diversification to enhance resilience among local populations and there is a need to highlight on the importance of strong local institutions and community-based organization in support to climate change adaptation.
- Use preliminary modeling to predict localized likelihood of CA success.
- Consider the obstacle of communally managed lands as well as lack of land tenure when promoting FMNR as they provide disincentives for farmers to undertake practices which demand longer time frames for their benefits to be seen. For example, increase efforts to address the unique situation of livelihood issues with all IDPs settlements.

Advice from CA trials:

- KALRO suggests that improved recording and documented rainfall trends that depict the onset of rains could help to maximize water use through conservation practices.
- Early land preparation and dry planting can be one of the areas that can be perfected to improve water use. Crop varieties with shorter vegetation periods can benefit more and greatly contribute to improving livelihoods.
- Fertility levels in Narok should be investigated and soil moisture retention should be monitored to improve local programming.
- Following tillage trials, KALRO recommends paying more attention to timely seedbed preparation and timely planting, and calls for more work to be done on the same experiments under the full season cultivation of a crop.
- Researchers recommend increasing the tree density on farms and using integrated soil fertility management (ISFM) to ensure nutrient availability.

Figure 13: *Insights and recommendations; conservation agriculture and agroforestry*



4.6 Climate-smart agriculture and gender

Authors: Patti Kristjanson (CCAFS / ICRAF) and Christine Jost (ICRAF)

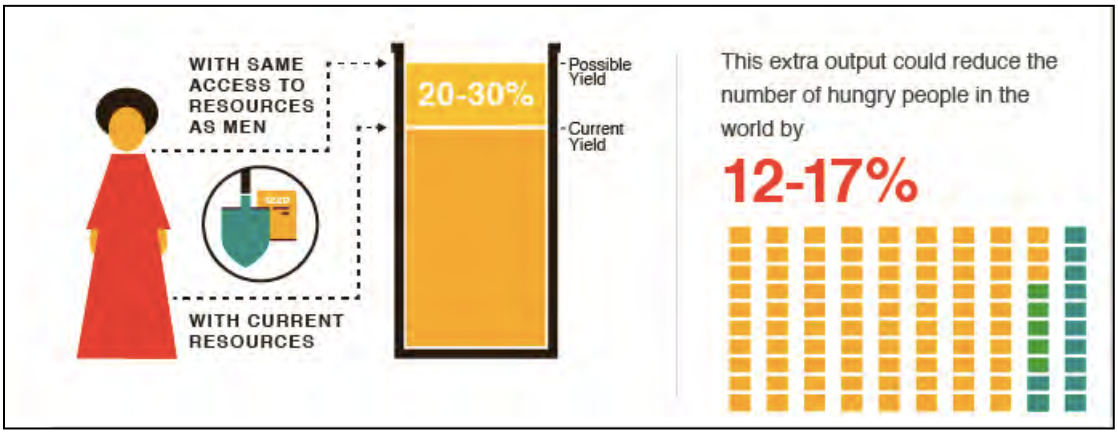
4.6.1 Background

Focusing on gender in terms of climate change and agriculture provides both a challenge and an opportunity. Rural women are at high risk to the impacts of climate change as their household responsibilities, such as childcare and the collection of firewood and water, are particularly climate-sensitive. Women take on more agricultural work as men migrate for labour, but have less access to agricultural resources such as land, extension services and inputs with which to adapt to variability and change. Furthermore, gendered social norms and roles can inhibit women's adaptive capacity.

On the other hand, the increasing importance of women in smallholder agriculture presents an opportunity. FAO's The State of Food and Agriculture 2010–2011 showed that if female farmers had the same access to agricultural resources as men, productivity could increase 20-30% and the rate of hunger could decrease by 12-17% (Figure 15).

Focusing CSA information, resources, technologies and practices on women is an important strategy for catalysing adoption and ensuring rapid and flexible adaptation to climate change. Targeting women and other vulnerable groups with CSA increases the likelihood of achieving the sustainable development goals. But, a focus on women will only be successful when gender norms that are currently inhibiting change are addressed.

Figure 14: *The potential results of providing women with the same access as men to agricultural resources*[31]



[31] CCAFS: http://ccafs.cgiar.org/bigfacts/#theme=climate-impacts-people&subtheme=gender

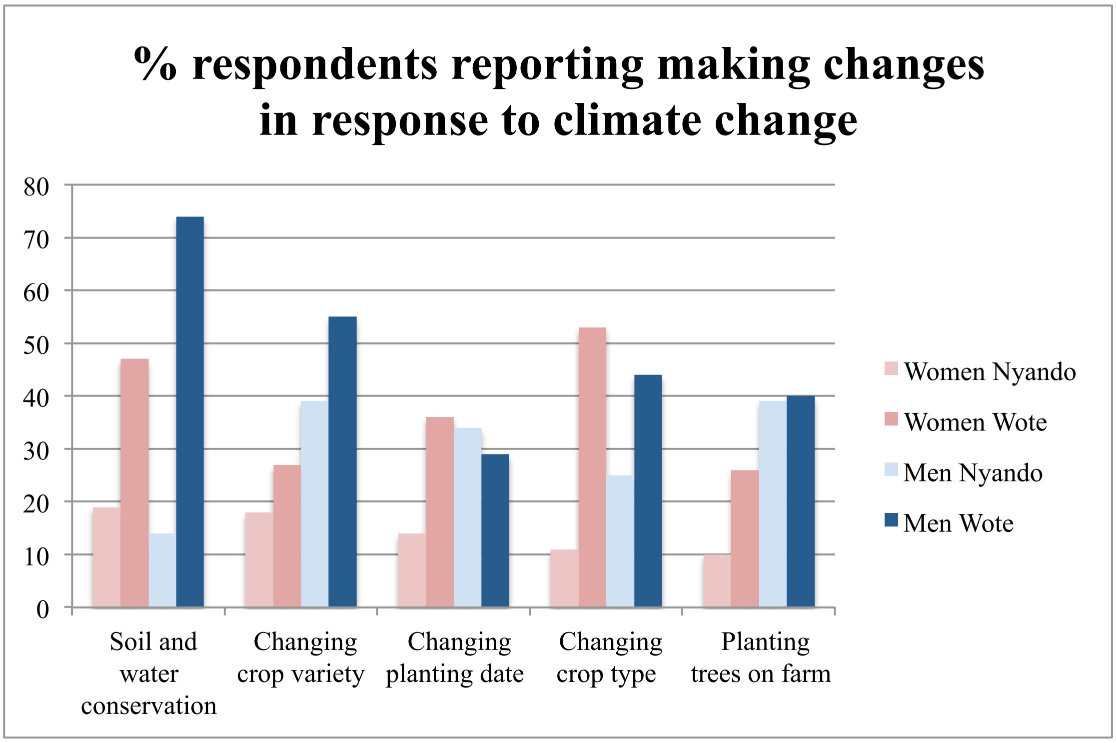
FAO. 2011. http://www.fao.org/docrep/013/i2050e/i2050e.pdf,

4.6.2 Activities and overview of results

CCAFS carried out a qualitative survey of climate change and gender in Nyando in 2012 and 2013, and in Wote in 2013. The surveys showed that there is still a very low awareness, often significantly lower in women than in men, of many water conserving and soil enhancing agricultural practices that will help build climate resilience (along with other livelihood benefits).

However, the survey also showed that women and men are becoming increasingly aware of and adapting to their changing climate - more so in Wote than Nyando (Figure 16). While very few large-scale changes such as water harvesting, mulching, composting, zero till and rangeland management are being made, smallholder farmers are making smaller changes like shifts in timing of planting or crops. In Nyando, fewer women than men have adopted climate-smart practices. Women are constrained in adopting CSA because they lack cash, assets and access to information, and because of cultural norms, their labor roles and lower literacy rates.

Figure 15: *The top five adaptations to climate change in Nyando and Wote 32*



Both men and women are accessing agricultural or climate information via radio, as well as through extension (although this is less prolific in Nyando than it is in Wote). 45% of men in Nyando obtain information from television as opposed to 15% of women. However, this might improve as TVs become more widespread in rural areas and shows like *Shamba Shape Up*, produced by the media company Mediae, provide viewers with information about CSA.

As exhibited by the survey, farmer groups and farmer field schools remain important sources of information for women and men, as few are able to access information from newspapers, cellphones or the Internet. With the increasing ownership of cellphones by women, this medium may have the highest potential to provide women with information on CSA.

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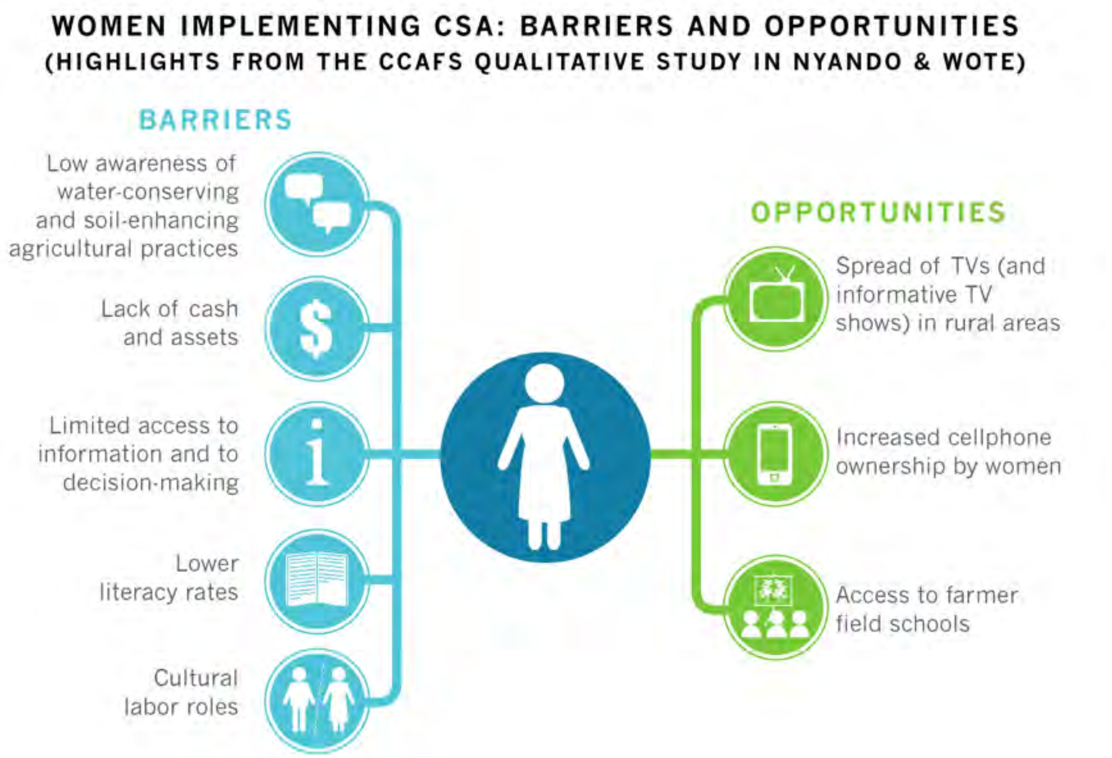
[32] Adaptation Actions in Africa: Evidence that Gender Matters, Working Paper No. 83, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Jennifer Twyman, Molly Green, Quinn Bernier, Patti Kristjanson, Sandra Russo, Arame Tall, Edidah Ampaire, Mary Nyasimi, Joash Mango, Sarah McKune, Caroline Mwongera, Yacine Ndourba

Given the cautious nature of CSA adoption by farmers, particularly women, in Nyando and Wote, there is still a huge need for more transformative change. Women tend to be less aware of CSA practices than men but, once aware, they are just as likely, or more likely, to adopt[33]. When women have more decision-making power, they are more likely to be engaged in climate-smart practices. So targeting women with information and training in these practices, and increasing their opportunities to access and use CSA practices, has a potentially high pay-off.

Figure 16: *The barriers to women implementing CSA and the opportunities to change this, as highlighted by the CCAFS qualitative study undertaken in Nyando and Wote*



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33 Bernier *et al.*, 2015. What influences CSA awareness and adoption of climate-smart agricultural practices? Evidence from Kenya. CCAFS Working Paper 79.

4.7 Farmer adoption, advisory and capacity development

Authors: Douglas Bwire (ICRAF), Lisa Fuchs (ICRAF), Caroline Mwongera (CIAT), Deborah Duveskog (FAO), Morgan Mutoko (FAO), Josephine Kirui (ICRAF), Rael Taiy (Egerton University), Christine Jost (ICRAF), Joyce Kweyu (Land O' Lakes)

4.7.1 Background

Even with all the evidence and best practice knowledge that can be garnered related to CSA, the mainstreaming and the out scaling are fully dependent on the knowledge sharing, capacity development, and incentives that will ensure farmers will be willing to adopt and adapt practices and reap benefits from their efforts. The actors in this working group presented important processes that had been used to support farmers through innovative knowledge sharing, advisory services and capacity development. A number of areas that need attention within this dimension include: finding the balance between external incentives and local ownership, defining ways to quantify process skills associated with capacity development, finding ways to "deliver as one" in CSA messaging while contextualizing for cultural differences, and taking advantage of the capacity development and advisory role to gather evidence and test for best practices in a robust way.

Table 14: *Contributing institutional efforts regarding farmer adoption, advisory and capacity development*

Institutions	Presentations[34]
ICRAF	The role of grassroots institutions in enhancing adaptation to climate variability in small-holder farmer systems
ICRAF	Accelerating Adoption of Agroforestry in Western Kenya (AAA) CSA and Gender
CIAT	Increasing food security and farming system resilience in East Africa through wide-scale adoption of climate-smart agricultural practices – IFAD-funded. Development of the Climate-Smart Agriculture Rapid Appraisal (CSA-RA)
FAO	Farmer Field Schools for CSA
FAO	Adoption of CSA practices and lessons learnt in the MICCA pilot project in Kaptumo, Kenya
FAO-ICRAF-EADD	Increasing dairy productivity using CSA practices in the MICCA pilot project in Kaptumo, Kenya
Egerton University	Integration of Climate Change Adaptation strategies through a Collective Learning Community in Mauche Ward, Nakuru County

[34] See the supplementary material to this report for more details

Table 15: *Overview of key activities, results and recommendations regarding farmer adoption, advisory and capacity development*

Key Activities	**Results**
• Participatory research approaches used to understand adoption trends, opportunities and challenges to adoption • Participatory research approaches for CSA training • Engaged rural institutions and strengthened their capacities to create a social infrastructure for CSA interventions	• There are context-specific barriers/constraints to well-being and CSA adoption, i.e. gender and cultural norms, weakened traditional institutions and biophysical context etc. • Readily available, successful gender-sensitive tools and processes that allow understanding of the local context (i.e. stakeholder mapping to understand linkages) • Analytical capacity of farmers facilitated by local experimentation and testing of CSA practices, which enhances uptake (i.e. through action research, farmer field schools etc.) • Adoption of CSA facilitated by collective action and strong local institutions
Recommendations	
• Deliberate efforts to ensure better understanding of the socioeconomic and biophysical context and constraints that inform farmers' decision-making • There is a need for genuine recognition of the role of culture and norms in uptake of CSA practices • Initiation and strengthening of inclusive local stakeholder platforms (i.e. across value-scales; linking research and extension; landscape level) is crucial for local CSA uptake • Serious commitment needed for multi-level and multi-sectoral interaction and joint planning processes • Capacity development needed for soft skills (facilitation, leadership, group dynamics etc.) alongside continual enhancement of hard skills • Proven participatory approaches for upscaling: action research, community planning/ participatory rural appraisal (PRA), gender disaggregated data collection and analysis, Farmer led- and farmer-driven extension services, farmer field schools, lead-farmer approach • Need for a consistent policy and regulatory framework to create an enabling environment	

4.7.1 Activities

The process of CSA adoption was investigated by several institutions in Kenya. Actors focused on identifying trends, barriers and constraints, as well as incentives to adoption, and assessed the efficacy of different collective and participatory methods for disseminating CSA information.

CIAT assessed the gaps and opportunities for targeting CSA across landscapes and communities by implementing a Climate-smart Agriculture Rapid Appraisal (CSA-RA). The CSA-RA provided an assessment of key barriers and opportunities to CSA adoption by collecting gender-disaggregated data, perceptions of climate variability, resource and labour allocation, as well as economic assessments at the household level. This approach combined participatory workshops, expert interviews, household/farmer interviews, and farm transect walks to gather and capture the realities and challenges facing diverse farming communities.

A FAO study by Mutoko, Rioux and Kirui (2014)[35] analyzed the constraints and incentives to the adoption of CSA practices and identified early benefits for farmers in its pilot site in Kaptumo Division, Nandi County. A household survey was conducted using structured geo-referenced questionnaires with 150 households and hosted five focus group discussions with 47 participants in 6 locations of the Kaptumo division. CSA practices targeted for review were: improved fodder production, agroforestry and fodder trees, tree nurseries and manure management (composting and biogas digesters). Data collected were on household and farm characteristics, MICCA project activities, CSA practices (adoption rate, constraints and incentives), food security and livelihoods benefits.

ICRAF engaged rural institutions and strengthened their capacities to create a social infrastructure for CSA interventions in Embu County by applying new technologies, modifying existing ones, and spurring changes in policies. It also tested tools for doing so at a local level. In several communities in Western Kenya (Nyanza and Kericho Counties), ICRAF used and tested the Asset-Based Community Development (ABCD) approach[36] devised by the COADY International Institute. The next project phase, to be implemented in 2015-2016, will combine the ABCD approach with a 'lead-farmer' approach, a modified extension methodology for local ownership, to scale up the project activities. Through group capacity building, the project has trained VSLA in financial inclusion and internal resource mobilization, provided agricultural training adapted to the agro-ecological zones and interests,

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[35] Mutoko, M.C., Rioux, J. and Kirui, J. 2014. Barriers, incentives and benefits in the adoption of climate-smart agriculture: Lessons from the MICCA pilot project in Kenya. FAO, Rome.

[36] The ABCD approach proposes to help communities devise development strategies *a priori* without additional external funds, based on their assets (personal, social, physical etc.). However, project implementers might decide to encourage general community engagement or the uptake of specific measures through additional funds, either directly (transport) or in kind (seeds, seedlings, provision of lunch and accommodation). This is often a response to external constraints such as tight timelines, the need to produce results or compensating community members for time and effort invested in project activities, but must remain part of a clearly devised strategy of when/where it is necessary to co-opt external funding, keeping in mind that external support might ultimately be counter-productive.

promoted agroforestry practices to enhance local adaptation and mitigation, promoted community-led vulnerability and capacity assessments and sought to understand the constraints for adoption of best practices. Previously made experience will inform the implementation of the next project phase. The project emphasized and engaged local partners in discussions on the impact of activities on well-being enhancement.

FAO-ICRAF-EADD in the MICCA pilot project also used innovative extension approaches to promote CSA Practices to improve dairy productivity in Kaptumo. Participatory and experts-based assessment (socio-economic baselines, capacity assessments, carbon balance analysis) coupled with round tables with farmers and local multi-stakeholders workshops were conducted to identify and develop a portfolio of context-relevant CSA practices. Practices were selected based on their suitability to local farming systems, crops, soils, climate and socio-economic conditions; their mitigation potential; and farmer perceptions and priorities in relation to yield, contribution to climate change adaptation, environmental benefits and capital, labor, land and knowledge requirements. The practiceswere later disseminated by volunteer farmer trainers. CSA practices and demonstration plot training for tree nursery operators were also launched.

Egerton University worked on the Integration of Climate Change Adaptation strategies through a Collective Learning Community in Mauche Ward, Nakuru County. The aim was to establish climate change related challenges experienced by smallholder potato producers via key informant interviews, focus group discussions, brainstorming in collaborative learning communities and questionnaires.

4.7.2 Overview of results

Results identified those CSA practices that experienced greater popularity among farmers throughout the various projects implemented. Adoption varied among different groups (i.e. gender difference) and contexts. The barriers/enablers, hindering and facilitating adoption are attributed to various biophysical and socio-economic factors and are best understood through a holistic look at entire production systems and their role in larger contexts. Adoption tendencies show that local experimentation and dissemination tools, such as action research and farmer field schools, enhance uptake rates and that collective and participatory methods of dissemination can be successful to encourage adoption.

Specifically, the CSA-RA led by CIAT identified key entry points for CSA outscaling. Labor requirements of cropping systems, by gender indicate that women provide much of labor. This has implications for promoting labor-intensive CSA practices. Furthermore, the CSA-RA highlighted that cash crops are handled mostly by men, compared to food crops grown for home consumption that are cared for by the women. In addition, institutional mapping of information and resource flows within the community revealed gendered differences in where people receive information. This implies that careful consideration of these differences be taken when targeting different genders and youth for CSA outscaling.

Different agricultural techniques are adopted differently by men and by women. In the two sites surveyed by ICRAF/CCAFS, men in both villages were more likely to change their soil and water conservation practices, crop varieties, and plant trees. However, while men were also more likely to adopt a changed planting date and crop type in one village, women were more likely to change these two practices at the other site. FAO/MICCA study also found that fewer agroforestry trees were planted among female-headed households - likely due to underlying socio-cultural barriers, namely tenure obstacles. Results show that there are successful gender sensitive tools and processes that allow the understanding of the local context, i.e. stakeholder mapping which highlight linkages.

Several studies provide lessons regarding the adoption rates of different practices and their underlying driving factors. A series of barrier categories were quantified to understand the importance of how a series of other factors were quantified (see the supplementary material to this report 1 for specific practices). Contributing factors were personal, socio-cultural, economic, institutional, environmental and included wellbeing and barriers to knowledge implementation (general and group dynamics). FAO/MICCA study gathered important insights on the success rates of different intervention tools and practices promoted in relation to livestock. FAO/MICCA found that some CSA practices worked well and others did not (see Figure 18). Establishment of fodders (Napier sorghum) and pastures (Rhodes grass) succeeded because training seeds were easily available, animals liked the feeds and they increased milk production. Moreover, adoption of improved fodder (88% Napier grass) was associated with secure land ownership and the capacity to hire labour for relatively longer periods. Lack of labor (48%) was one of the main barriers.

The establishment of fodder trees (*Calliandra* and *leaceana Tricandra*) was successfully adopted because of the training provided on nursery establishment, as these fodder trees are a good source of protein for the animals. The planting of agroforestry trees was easy for farmers to adopt, groups enabled the management of tree nurseries and the positive impact of the practice was noticeable. Secure land tenure (50%) was cited as a necessary incentive for adopting agroforestry (83% Croton and 69% Grevillia). Trees improved the environment, increased food security and did not require a lot of land. Trees improved the environment, increased food security and did not require a lot of land. Participation in trainings increased significantly the adoption of improved fodder, agroforestry, composting and tree nursery.

Other CSA practices were less successful. Installation of biogas units and the construction of zero grazing units were limited as few farmers have improved breeds, and as they require skilled labor (particularly for the biogas unit construction) and a high initial capital investment. Artificial insemination and use of improved livestock breeds were hindered by lack of inseminators and inadequate knowledge. While locally available trainers and farmer exchange visits would have enabled the success of these practices, inadequate avenues for the dissemination of information limited practice adoption. Media such as posters were sometimes mistaken for advertisements and difficult to access for the illiterate, while others formers of media were too costly for farmers to access. The MICCA partners (FAO–ICRAF-EADD) noted agricultural dynamics of change as an additional limitation that needs to be considered when planning interventions in, for example that there is general decline in the land allocated to natural pasture while that of planted fodder is increasing, or that herd size is declining while milk production per cow is increasing for the improved breed.

The MICCA study conducted in the Kaptumo Division (Mutoko, Rioux and Kirui, 2014)[37]found that low adoption rates for improved management of manure were influenced by a combination of factors, including declining land size, the low presence of improved breeds, falling tea incomes and the emergence of Maize Lethal Narcosis Disease. Fodder production was constrained by a lack of labor in 48% of households, lack of information on suitable fodders (44%), small land holdings (37%) and the unavailability of planting materials (26%). Main challenges faced in the establishment of tree nurseries were: unreliable rainfall, damage by pests and diseases and unavailability of preferred seeds. Fewer farmers practiced

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[37] http://www.fao.org/3/a-i4396e.pdf

composting or covered manure, predominantly due to open grazing. Just 1% of households used manure in biogas digesters, attributed to a lack of capital and a lack of technical knowledge of how to install the digesters.

Efforts by ICRAF in Embu and Bongoma to mobilize local actors resulted in the application of a range of adaptation strategies by households in response to rainfall variation. Among the most common strategies, households diversified their crops (60%), planted trees (56%), changed their planting calendar (46%) and established soil and water conservation measures (35%). Collective action was found to increase adaptation due to enabling components such as knowledge sharing, collective decision-making, income sharing, resource mobilization, group management of assets, market information sourcing, collective marketing of produce, jointly formulating rules for the collective management of natural resources and labor sharing. The project concludes that there is great potential for CSA by engaging rural institutions through collective action, as well as potential to be included in context specific planning. Collective action yields high returns/impacts: it helps to maximize processes/activities to optimally reduce risk, share benefits and facilitate application of CSA adaptation options. Rural institutional strengthening also creates enabling conditions for CSA at the local level.

Locally inclusive and participatory methods for selecting and introducing CSA practices positively impact adoption rates. ICRAF results regarding the use of collective action to spur CSA adoption, show that project group members are more likely to engage in detrimental coping strategies[38], small scale business and positive adaptation strategies, such as the use of farm inputs, agroforestry practices and water harvesting and management. The use of ABCD strengthened both the capacity to take action and empowered farmers. Nonetheless, different local constraints/barriers lead to different adaptation strategies:

- In Lower Nyando, water scarcity resulted in the implementation of strategies focused on more income diversification and small-scale business;
- In Middle Nyando, an area with water abundance, more cash crops, agroforestry engagement and sales of tree products were favored;

[38] In this context, detrimental coping strategies included a number of food-related strategies (reducing the number of meals taken per day, reducing the portion per meal, reducing the quality of food etc.) and non-food related strategies (eating seeds reserved for planting, selling farm tools, selling livestock etc.).

- On the Nyanza/Kericho boundary where insecurity persists, no major livestock ventures were undertaken to reduce exposure and vulnerability.

Egerton University's Collective Learning Community Project identified adoption trends relevant to a zone with increasing rainfall, combined with increased variability and unpredictability regarding the onset of rains. Increasing rains were perceived as having increased erosion and thereby decreased soil fertility. Increased complication of the road network due to rains hampers market access. Meanwhile moisture on crops increases the need to pesticides and fungicides thereby increasing costs of production. Among the 66 farmers surveyed, different coping strategies were adopted to varying extents. The most popular coping practices adopted were pest and disease control and timely planting, while the least popular was irrigation. Water harvesting, crop diversification and new varieties were also adopted among respondents. (See the supplementary material to this report for details.)

Farmers who participated in farmer field schools (FFS) in the Kitui district attained higher yields than their district wide counterparts. Various studies confirm these findings. About 50% of farmers who participated in FFS had a high to very high level of knowledge of technologies disseminated, while more than 80% of the non-FFS participants had less than 50% of same knowledge[39]. The value of crop productivity per acre for FFS members increased by about 80% in Kenya, and doubled among female-headed households[40]. However, the impact among very poor farmers varies from the norm: poor and very poor farmers experienced decreases in their yields from 64% to 43% post FFS[41].

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[39] Bunyatta, D.K., J.G. Mureithi, C.A. Onyango and F.U. Ngesa. 2006. Farmer Field School Effectiveness for Soil and Crop Management Technologies in Kenya. Journal of International Agricultural and Extension Education, 13(3), 47-63.

[40] Davies, K., Nkonya, E., Mekonnen, D.A., Odende, M. & Miiro, R. 2012. Impact of Farmer Field Schools on Agricultural productivity and Poverty in East Africa. World Development 40, 402 – 413.

[41] Friis-Hansen, E. & Duveskog, D. 2012. The empowerment route to well-being. An analysis of Farmer Field Schools in East Africa. World Development 40, 414 – 427.

Figure 17: *An overview CSA practices that were successfully and unsuccessfully implemented in the MICCA pilot project by FAO-ICRAF-EADD*

OVERVIEW OF THE ADOPTION OF CSA PRACTICES IN THE MICCA PILOT PROJECT BY FAO–ICRAF-EADD

Factors in successful adoption

Establishment of fodders (napier sorghum) and pastures (rhodes grass)

- Training seeds made available
- Animals like the feeds
- Increased milk production

Establishment of fodder trees Calliandra and leaceana Tricanda

- Nursery establishment training provided
- Source of protein for animals

Agroforestry

- Tree nurseries managed in groups
- Improved environment
- Increased food security
- Limited land required

Barriers to successful adoption

Biogas units

- Inadequate means to disseminate information
- High capital investment
- Require skilled labor

Artificial insemination

- Lack of knowledge
- Lack of inseminators

Manure management

- Declining land size
- Open grazing limits manure collection

Fodder production

- Lack of labor force
- Lack of information on suitable fodders
- Unavailability of planting materials
- Small land holding

Establishment of tree nurseries

- Unavailability of preferred seeds
- Unreliable rainfall
- Damage by pests and diseases

4.7.3 Insights and recommendations for future programming

Understanding of local context:

- Deliberate efforts must continue to ensure a better understanding of the socio-economic and biophysical context and constraints that inform farmers' decision-making
- There is a need for genuine recognition of the role of culture and norms in uptake of CSA practices
- Finding the balance between external incentives and local ownership (what are sensible and sustainable incentives?)

Inclusive approach and capacity building:

- Initiation and strengthening of inclusive local stakeholder platforms (i.e. across value-scales; linking research and extension; landscape level) is crucial for local CSA uptake
- Encourage effective collaboration to harness synergy from other partners, continuous involvement of local leadership to enhance project ownership
- Including line ministries to facilitate capacity building, create and strengthen networking and linkages with media
- Serious commitment needed for multi-level and multi-sector interaction and joint planning processes
- Capacity development needed for soft skills (facilitation, leadership, group dynamics etc.) alongside continual enhancement of hard skills
- Need a consistent policy and regulatory framework to create an enabling environment.
- Clear policy on how small-scale farmers who adopt CSA practices would also financially benefit from carbon credit or such other schemes

Successful and proven participatory approaches for upscaling:

- Action research
- Community planning/PRA
- Gender disaggregated data collection and analysis
- Farmer led- and farmer-driven extension services
- Farmer field schools
- Lead-farmer approach

Interventions that build on successful practices for adoption of CSA and address limitations:

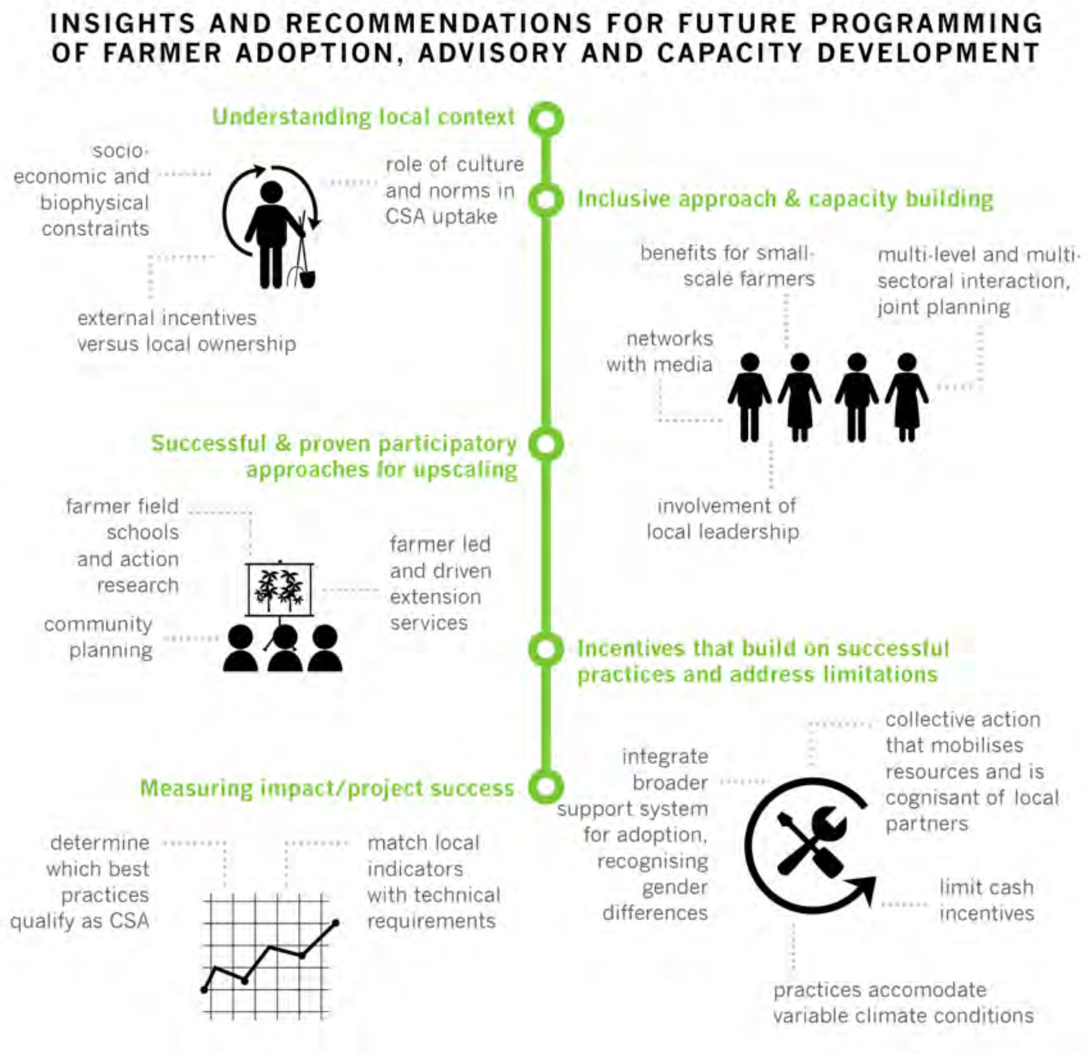
- CSA adoption can be addressed through collective action that is cognizant of local partners' agency freedom, ideas and interests
- Collective action that mobilizes resources through table banking, merry-go-rounds [42], cost-sharing and group credit access
- Must facilitate adoption by integrating broader support systems (access to knowledge, insurance products, and financial opportunities)
- Create groups of volunteer trainers, include trainers in the development agenda
- Practices need to be flexible to year-to-year variable climate conditions
- Interventions need to be cognizant of the differing agricultural labor responsibilities of men and women, as well as the different institutional linkages and information flows amongst both genders
- Participants considered whether a cash reward should be provided for farmer field school attendance, reaching the conclusion that no reward would mean lower attendance rates, but higher quality engagement by those who do remain

Measuring impact/project success:

- Defining ways of measuring and monitoring 'soft skills' (empowerment, gender dynamics etc.)
- Success indicators are not universal (how can local interests and indicators be matched with technical priorities and objectives in research and development? How to ensure harmony between global frameworks and local indicators?)
- Which 'best practices' actually qualify as CSA and do we have robust evidence?

[42] Details are found at http://www.irinnews.org/report/88795/kenya-merry-go-round-micro-finance-keeps-slum-residents-fed

Figure 18: *Insights and recommendations*



4.8 Markets and microfinance

Authors: Noelle O'Brien (DFID Kenya) and Joab Osumba (FAO)

4.8.1 Background

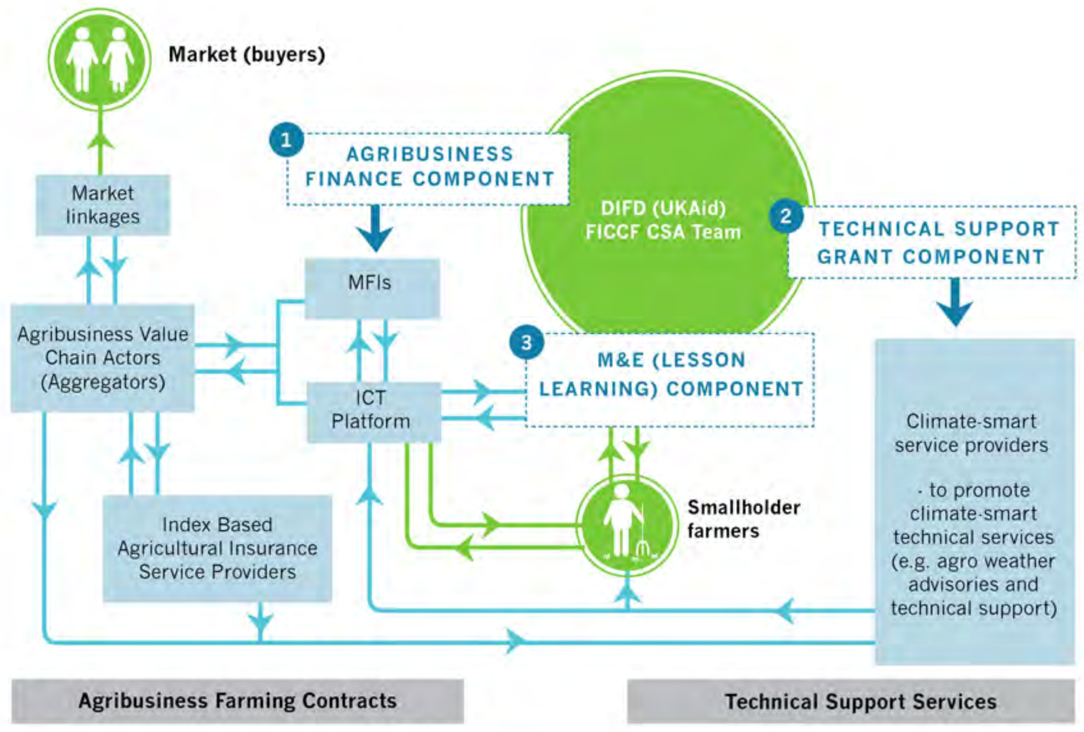
Commercial banks are reluctant to engage in sound climate change projects due to a lack of familiarity and a lack of risk assessment/project finance methodologies. In order to address this market failure, DFID Kenya has designed a Smallholder Climate-Smart Agriculture Program to be delivered through its Finance Innovation for Climate Change Fund (FICCF), managed by the DAI/HTSPE, Matrix Development and IISD Consortium (Figure 20).[43] The program aims to support the scaling out of innovative private sector investments in agricultural adaptation/resilience and low carbon interventions, services and assets in the agriculturally high production zones (especially non-ASAL areas) of Kenya. The agribusiness finance component of the program provides repayable grants to selected agribusiness partnerships led by micro-finance institutions (MFIs) for on-lending to small-scale farmers and private sector actors along the value chain for selected commodities. The MFI partnerships that successfully emerged through the competitive bidding process include K-Rep Bank, ECLOF MFI, Century DTM Bank and Inuka Africa MFI.

Table 16: *Scope of DFID's FICCF CSA Program*

MFI Partnerships	Enterprise	Counties to cover
Krep Bank & Partners	Cassava	Machakos, Tharaka Nithi, Siaya, Busia, Homa Bay, Migori, Vihiga, Kitui, Makueni, Kisumu
	Sorghum	
ECLOF MFI & Partners	Dairy	Bomet, Kericho, Kirinyaga, Murang'a, Nakuru, Nyandarua, Uasin Gishu, Embu, Meru, Nyeri
Century DTM Bank & Partners	Indigenous chicken	Bungoma and Trans Nzoia
Inuka Africa MFI & Partners	Dairy	Nyandarua and Nakuru

43 Details are found at http://www.ficcf.com/index.php/climate-smart-agriculture/csa

Figure 19: *Agribusiness and Technical Mechanisms of the DFID Finance Innovation for Climate Change Fund CSA Program*

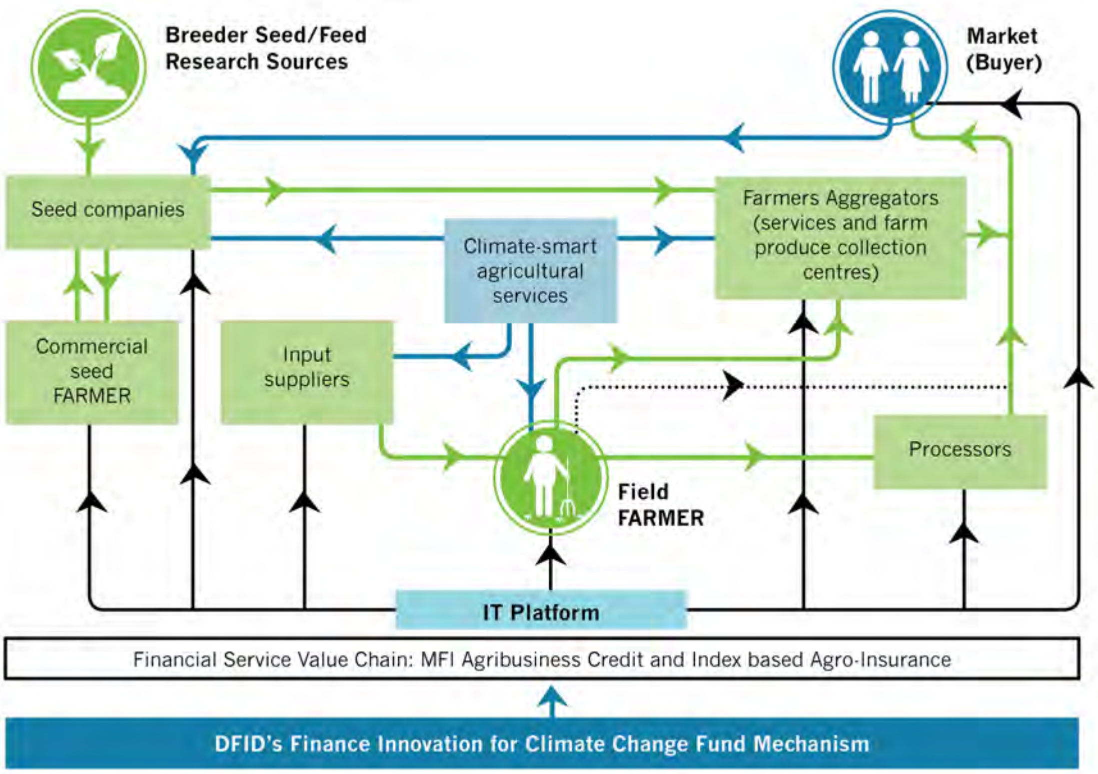


Running in conjunction with the agribusiness loan program is a technical support grant component that provides agro-weather advisories and complementary CSA-oriented technical services. The process provides learning points for private sector involvement in CSA among smallholder farmers, and documents the lessons from across the MFI contracts.

4.8.2 Activities

The following production systems were identified as commercially viable, based on the analysis conducted by FICCF and the level of interest indicated by the MFIs: sorghum/legume intercrops, cassava, dairy feed systems, dairy herd management and semi-commercialized indigenous chicken systems. These systems are supported through approaches across the value chain, as illustrated in Figure 21.

Figure 20: *Stages of the value chain where CSA funding support may be required*



Farmers are contracted by the MFI partnerships and have the option to take loans to produce the identified commodities. The loans to the farmers are used as investments to increase production efficiency, examples of which include the following:

- Production of crop (seed) planting materials, livestock starter materials and the management of feed systems;
- Purchases of appropriate seeds and feed material (in a broad sense – crop seed, day-old chicks, fingerlings, heifer calves);
- Soil testing, analysis and soil fertility management – to shift away from fertilizer recommendation mode to nutrient requirement mode;
- Purchase of nutrients recommended in the soil analysis results;
- Water harvesting/management such as water tank or drip irrigation kit installation; and moisture conservation;
- Farm technologies (structures, machinery, tools, equipment, implements, etc.) for land preparation, planting, IPM, harvesting, post-harvest handling, storage, etc.;
- Structures, tools, equipment and implements for production, processing and storage;
- Provision of payable extension services e.g. land preparation, improved planting/starter materials, crop protection services such as weeding, pest/disease control, farm produce

harvesting, farm produce transportation and storage, commodity processing and value addition, improved individual and group marketing, etc.

Technical support services involve building the capacity of farmers to increase ecosystem resilience in the areas of water harvesting and conserving soil moisture, increasing on farm tree cover, increasing soil cover, recycling residues and reducing emissions as a co-benefit.

Downscaling of seasonal weather forecasts to the specific counties and the various agro-ecological (and agro-climatic) zones are an essential aspect of the program's technical support services component. It is expected that this downscaling will increase adaptive capacity and resilience especially for crop-based interventions, and to some extent for dairy forage production and herd reduction with increased productivity.

The MFI partnerships have entered into collaboration arrangements with KMS using the technical support funds to downscale seasonal weather forecasting to ensure that the appropriate agro-weather advisory information is available. The MFI partnerships also have access to index based insurance initiatives for weather and for yield. All partners hold at least two field agro-weather advisory workshops with contracted farmers every season to disseminate this information, once at the beginning to plan the season and the other at the end to review the season and plan for the next. Weather information (in the form of alerts and notifications) is also communicated to contracted farmers via IT platforms and/or local radio.

5. Overall recommendations for future programming of CSA in Kenya

The CSA research and development projects implemented by various institutions throughout the non-ASAL areas of Kenya that were presented at the workshop, provided a comprehensive state of knowledge and review on progress, potential and challenges to CSA promotion in the country. Workshop participants merged scientific evidence with practical experience to determine key actions and processes considered as promising for scaling up climate-smart initiatives for Kenya, and showed established evidence and integration of the policy dimension. Lessons learnt highlight the need for continued contextualized research and participatory processes for appropriate planning, understanding long term implications and for maximizing success rates of future CSA efforts. These are presented within the dimensions of a) ensuring CSA is contextualized within Kenya's development goals; b) CSA programming for future research and practice investment; and c) emerging policy messages from evidence and experience.

Figure 21: *Three key recommendations from thematic working groups*

5.1 CSA within the Kenyan sustainable development context

While CSA is most generally defined in terms of simultaneously ensuring increased resilience and adaptation, enhanced mitigation or low emissions development, and improved productivity and food security, CSA efforts must be contextualized within and tested for their capacity to achieve the desired outcomes of the Kenyan population as outlined in its Vision 2030.

"To create a globally competitive and prosperous nation with a high quality of life by 2030, that aims to transform Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment - anchored on three key pillars; economic, social and political governance"

The National Climate Change Action Plan (2013) of the Government of Kenya supports the Vision 2030 calling for a pathway to address climate change that:

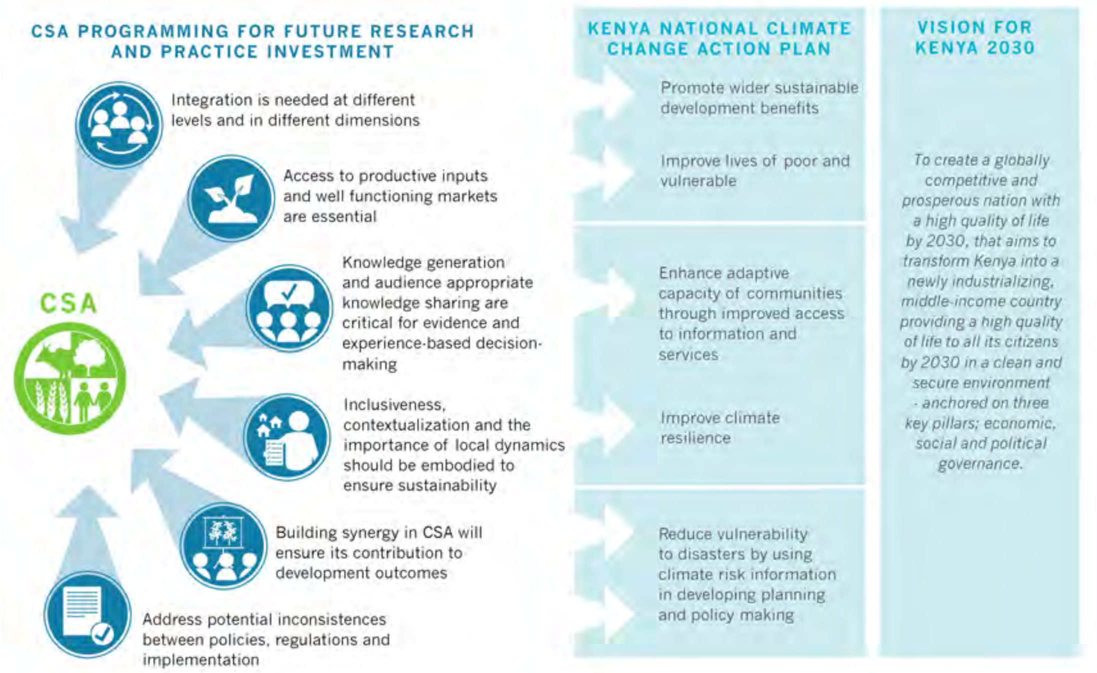
- Promotes wider sustainable development benefits;
- Improves the lives of the poor and vulnerable;
- Improves climate resilience to further Kenya's people-centred development strategy;
- Enhances adaptive capacity of communities through improved access to information and services; and
- Reduces vulnerability to disasters by using climate risk information in development planning and policy-making.

The efforts of the Kenyan Government with its many partners demonstrate a deep commitment to addressing climate change, firstly through enhancing adaptation, resilience and productivity for farmers and secondly, where feasible, to utilize low emission pathways to development[44]. Addressing Climate Change in the overall Kenyan context means that CSA must also be development smart. This means that the CSA efforts must also be tested for their capacity to address a wider set of development priorities in the country, such as increased income and greater livelihoods and employment opportunities; greater nutrition, dietary diversity and health; enhanced energy and food systems supporting both urban and rural dwellers, decreased inequities associated with marginalized groups within the population; enhanced education opportunities; and functioning markets and incentive systems, among others.

The overall insights in the subsequent section provide additional insights to CSA outscaling programming for future investments including dimensions of inclusive interventions, sensitivity to social and cultural norms, knowledge generation, use of bottom up approaches, tailored information, linking research, practice and policy and integration at farm and landscape level.

[44] Government of Kenya. 2012.

Figure 22: *Recommendation highlights for CSA within integrated farming systems in Kenya*



5.2 Overall insights for future programming and out-scaling investments in Kenya

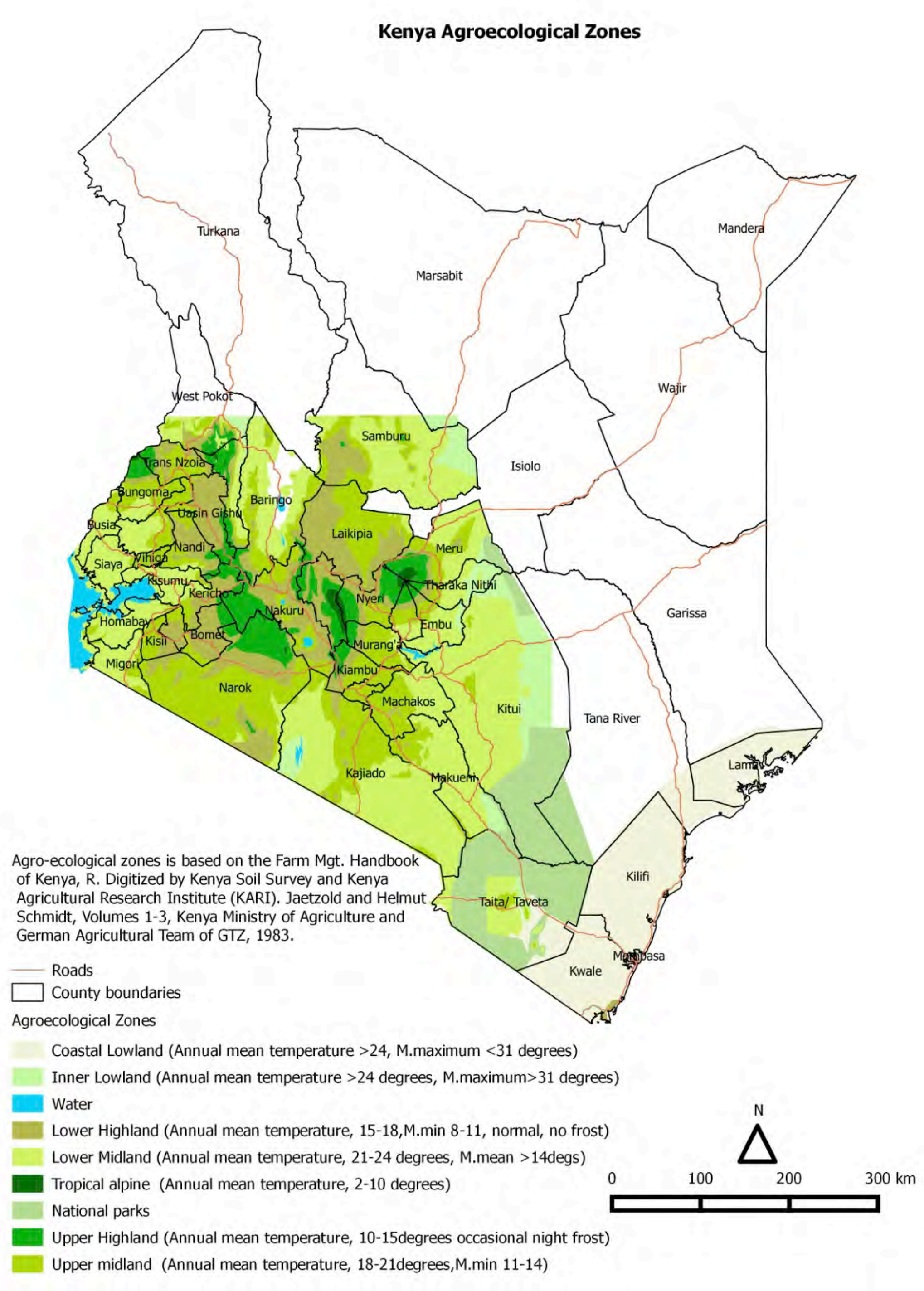
5.2.1 Agroecological and socio-economic context

This workshop focused on climate smart agriculture applications in the non-ASAL areas of Kenya. The map in Figure 23 shows the agroecological zones of the non-ASAL areas in Kenya, which the CSA efforts and recommendations described in this document support. The different projects presented during the workshop drew from applications in 30 Kenyan counties including: Baringo Bomet, Bongoma, Busia Embu Homa Bay, Isiolo, Kaijado, Kericho, Kiambu, Kirinyaga, Kisumu, Kitui, Machakos Makueni, Meru, Migori, Murang'a, Nairobi, Nakuru, Nandi, Narok, Nithi, Nyandarua, Nyanza, Nyeri, Siaya, Tharaka Vihiga, Trans Nzoia, Uasin Gishu as well as relevant projects from Nwoya District in Uganda and Kolero in Tanzania.

The CSA work in Kenya represents a wealth of information on what works and what does not work in terms of adopting and scaling out climate smart agriculture to benefit farmers and other stakeholders, however these implementation efforts of integrated practice and process must be contextualized based on specific biophysical/agroecological and social and cultural factors. There are still gaps to be filled. A major undertaking to further benefit Kenya's

Climate Smart Agriculture efforts would be to continue to track various investments in CSA in Kenya, coalesce the evidence and experience and harmonize investment decisions based on remaining priorities.

Figure 23: *Agroecological zones and major roads across counties in the non-ASAL areas of Kenya*[45]



[45] J. Wanjara and T. Vagen (ICRAF), GeoScience Lab (2015) with Leigh Winowiecki (CIAT)

5.2.2 Recommendations for out-scaling and programming

1. Integration is needed at different levels and in different dimensions. Integration must be applied spatially, sectorally and across institutions and knowledge systems. Projects' findings consistently pointed to the need to have holistic and inclusive approaches. CSA interventions should be mainstreamed across scales from farm to landscape, local to international, and short to long term. Interventions should be inclusive, meaning that they develop through the cooperation of various stakeholders, governmental, civil society and private sector actors at different scales, and should utilize bottom up approaches to research and implementation for better rates of adoption. CSA in Kenya must continue to link and integrate research, practice, policy, and investment. When knowledge systems are synergized from the outset, decision making at all levels can build on a broader base of scientific evidence and field experience and investments can have greater impact.

Integrating CSA in whole farm systems and landscapes as well as linking adaptation and low emission development builds synergies and addresses trade offs among different components to achieving overall desired CSA outcomes. The local complexity that determines CSA project success calls for undertaking a whole farm system approach that moves beyond individual practices. Scaling out CSA requires moving beyond individual practices to integrate practices and processes through whole farm and whole landscape systems and approaches. This is particularly true in the case of livestock, where mitigation/adaptation outcomes have the potential to overlap. The integration of livestock, fish, crops and trees and associated practices on farm or at the landscape can more readily enhance productivity, resilience and carbon sequestration, and thus the achievement of all dimensions of CSA. Integration must also be considered across value chain components. Projects must ensure a high level of adaptation to local physical and social contexts.

Addressing climate change will continue to prompt intentional linkages across agriculture, environment, health, finance, education and other society-related sectors, as well as across local to national and international decision making levels. The establishment of an effective institutional framework to mainstream climate change response across relevant sectors and into integrated planning, decision-making and implementation, at both the national and county levels will reduce compartmentalized efforts. CSA must be proactively integrated into national and county budget planning and allocations.

Enhanced and reinforced linkages among science, practice and policy increase effectiveness and greater returns on investment. Research and technology development activities must be coordinated and synergized to advance climate change efforts (research in development), including CSA. And when policy makers can interact with evidence and tools, resulting from research and practice, more informed decisions can be taken.

2. Access to productive inputs and well functioning markets are essential. CSA projects must work to develop a wider enabling environment for CSA by supporting links with the greater business and institutional framework within landscapes. Integrating surrounding market strategies for CSA is key. Interventions should be focused on aligning the incentives for farmers, and supporting linkages between demand and supply side at different scales. Systems level thinking needs to be applied, including taking into account farm and landscape CSA as well as value chain assessments and actions which enable climate smart development, more equitable transactions and markets that support CSA efforts. Access to financing and different local to national investment schemes for appropriate CSA implementation continue to be needed and evolved. Safety nets such as insurance and micro-finance also need to be supported. Financial resources apply to productive inputs (knowledge and technologies) as well as incentives to adapt more integrated approaches.

3. Knowledge generation and audience appropriate knowledge sharing are critical for evidence and experience-based decision-making. Initiation and strengthening of inclusive local stakeholder platforms (e.g. across value-scales; linking research and advisory efforts; landscape level) is crucial for CSA uptake at local level. The urgency of change that is needed means that knowledge resulting from research, practice and policy must be integrated and mutually supporting and consistently communicated across the various communities of practice. Agriculture, environment and societal dimensions (emphasizing gender as well) can no longer be segregated but rather must be fully and intentionally integrated to accelerate learning across disciplines and subsequently achieve synergies and impact.

Shared experiential and scientific evidence vastly improves collective understanding and clarity on response options. Awareness raising and capacity development of farmers, pastoralists, fisher people and forest dwellers for implementing appropriate climate-smart actions on the ground requires continuous support. Climate change awareness and mechanisms for addressing implications can also be built into core curricula for all age groups, and a particular emphasis on youth will help ensure sustainability of agriculture. Infrastructure and effective mechanisms for the dissemination of timely and tailored climate information and other productive inputs are crucial for agricultural and natural resource managers.

The design and sharing of relevant, tailored information products and advisory services to the appropriate scales will enhance farmers' decision-making and adaptive capacity. Further, it is critical to generate and share knowledge, raise awareness and build capacity through well-developed, local farmer leadership and innovative capacity development approaches with in-built follow up and support for adaptive management. Planning jointly among stakeholders builds awareness, capacity and ownership. When stakeholders commit to multi-level and multi-sector interaction and joint planning processes, knowledge & gaps are clarified and implementation is owned and accelerated.

4. Inclusiveness, contextualization and the importance of local dynamics should be embodied to ensure sustainability. To accelerate adaptation, resilience and low emissions development requires the authentic engagement of stakeholders at all levels and sharing among and across diverse knowledge systems. Strengthening of inclusive local stakeholder platforms and a commitment to multi-level and multi-sector interactions and joint planning processes will accelerate positive impacts.

Climate-smart Agriculture (CSA) interventions must be developed within the existing social and cultural norms. Deliberate efforts must be undertaken to ensure better understanding of the socioeconomic and biophysical context, constraints and opportunities that inform farmers' decision-making.

Agriculture is a major economic contributor to Kenya's national GDP. With the migration of men for off-farm labor, women are increasingly managing the land and resources. Greater emphasis needs to be placed on building the capacity of women, who make up the majority of farmers in Kenya yet whose access to information and productive inputs are more limited than their male counterparts. Authentic engagement of women and youth will accelerate CSA impacts. Focusing CSA information, resources, technologies and practices on women is an important strategy for catalyzing adoption and ensuring rapid and flexible adaptation to climate change as well as increased food security. The scaling up of CSA in Kenya should pay due attention to the needs of youth as the next generation ensuring their understanding of climate change, land resources management, and CSA implementation and adaptive management to deal with on-going change. These elements need to be included in school curricula.

Understanding local dynamics also helps to address another important concern – remaining cognizant of the resulting trade-offs and potential of rising conflicts which may grow due the changes occurring because of climate change and during with CSA adoption. Indicative examples of trade-offs and rising conflicts to consider were provided:

- Tensions may arise within and across different types of agricultural systems. These tensions may manifest themselves differently, particularly between the ASALs and non-ASAL regions of Kenya. Sensitivity of emerging crop calendar changes, which can impact local relations between producers and pastoralist grazing, and careful attention to the gender implications are needed.
- The timing or effectiveness of manure management approaches, either as direct manure application or indirect processing through biogas generation and subsequent slurry application need further exploration as they affect both adaptation and low emission processes.
- Trade off between crop residues for soil cover and as animal feeds must be carefully considered when promoting on farm changes of practices.
- The scale of impact must be considered differently in different contexts. For privately owned land, divisions are increased from generation to generation affecting the sizes of parcels and how they can be influenced. Further, the lack of land tenure will undermine long-term impacts of CSA by reducing investments in land health, trees, and other CSA practices.

5. Building synergy in CSA will ensure its contribution to development outcomes. There is a need emphasize practices that can simultaneously address resilience/adaptation, mitigation/low emissions development and food and nutrition security, as well as the incentives and capacities to reinforce these practices. Towards that end, it will be important to create assessment methodologies that can simultaneously capture mitigation and resilience as well as changes in food security. It will also be important to ensure that CSA practices add value within the larger development context, including enhancing employment, income, nutrition, education and market opportunities and contributing to overcoming social inequities.

6. Address potential inconsistencies between policies, regulations and implementation. As greater knowledge becomes available for implementing CSA, analyses of regulatory and policy frameworks need to undertaken to ensure that they are supporting rather than discouraging CSA actions and upscaling.

5.3 Emerging policy messages from evidence and experience

The workshop concluded with the establishment of joint policy messaging developed with the CCU of the MALF and the CC Secretariat of the MEWNR as input to the Kenya Climate Change Policy Framework as well as for circulation during the UNFCCC COP-20 in 2014. The full document can be viewed in the Policy Brief entitled: Transitioning Toward Climate Smart Agriculture in Kenya: Linking research, practice and policy[46.] Key policy messages are summarized below:

Consider development priorities. Climate-smart agriculture (CSA) must contribute to building opportunities for employment, education and market opportunities. CSA is smart precisely because it addresses a range of key development issues.

Connect interdisciplinary research, practice and policy. Research, agricultural activities and policy development should be integrated from the start of any CSA initiative. This improves decision making at all levels because the decisions are based on a broader base of scientific evidence and field experience.

Integrate farm and landscape systems. Integrating the production of livestock, fish, crops and trees on farms or throughout the entire landscape can enhance productivity, strengthen the resilience of farming systems and reduce and remove greenhouse gas emissions.

Include women and youth. Specific attention needs to be paid to building the capacity of women, men and youth who manage natural resources. Farming skills, as well as leadership

[46] Details can be found at http://www.fao.org/3/a-i4259e.pdf

and facilitation skills can be built with the support of local groups that can tailor climate information to community needs and make available necessary materials.

Connect policy and regulation. Inconsistencies between policies and regulations can undermine CSA.

Fill knowledge gaps. CSA still faces a number of knowledge gaps, including a lack of:

- baseline data for measuring, reporting and verifying the effectiveness of CSA practices;
- reliable, downscaled climate and weather forecasts;
- country-specific emission factors;
- an understanding of the change in the greenhouse gas balance and other impacts brought about by the integration of livestock and/or fish farming, conservation agriculture and planting trees on farms and in the landscape; and
- evidence of mitigation options offered by alternative energy sources
- appropriate inputs to advance CSA, evidence of reduced GHG emissions through alternative energy sources in larger value chain analyses
- emission factors from livestock and aquaculture in integrated farming systems including livestock and conservation agriculture with trees interactions;
- incentives for manure management, reliable climate forecasts, greater understanding and implementation of appropriate finances and insurance schemes, and great awareness raising at farmer level.

Measurements of the benefits of CSA. Analysis from the thematic working groups and expert analysis identified the need for improving approaches and indicators to monitor and evaluate the effects of CSA on various socio-economic and biophysical properties. It was suggested that both participatory monitoring and evaluation of CSA alongside biophysical assessments are needed. This includes for example, traditional measurements of agricultural yields, farmer evaluation, participatory workshops and discussions around prioritization, among other approaches. These assessments ultimately need to feed into global frameworks in order to inform local CSA investments. These frameworks must establish how success should be defined, in terms of adoption, yield and agricultural productivity, adaptation and mitigation

Mainstreaming CSA. Workshop results highlighted the need to mainstream CSA at national and sub-national levels throughout all levels of the institutional framework, including the level of the village, ward, sub-county, county and national. Enhancing coherence in the institutional framework can provide a mandate for wider cooperation amongst stakeholders, including research and development organizations and ministries. Future work should aim to strengthen county planning efforts in their implementation of Integrated Development Plans aligned with national level initiatives. Forums building on existing structures at the national and county level (e.g. the National Drought Management Authority) and harmonization among investors and donors are needed to mainstream CSA into national programming, budgetary processes and prioritization of investments. A mainstreamed framework can promote greater interactions across the intellectual capital held within compartmentalized efforts and provide incentives for cooperation and synergistic decisions. The ICRAF Stakeholder Approach to Risk Informed Evidence Based Decision Making (SHARED) could offer a structured framework for engaging and interacting with the relevant knowledge systems and testing decisions for prioritized investments based on up-to-date evidence and experience and grounded in desired long term development outcomes.

Lastly, the exercise that was carried out for CSA in the non-ASAL areas should be implemented for the ASAL areas to complete a robust Kenya-wide assessment of CSA and provide comprehensive input to future programming.

RESEARCH PROGRAM ON

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