State of Knowledge on CSA in Africa

Case Studies from Rwanda, Tanzania and Zambia

FARA
Forum for Agricultural Research in Africa

Norad

NEPAD
TRANSFORMING AFRICA

State of Knowledge on CSA in Africa:

Case Studies from Rwanda, Tanzania and Zambia

Mark M. Msaki
Executive Director
Food Security Welfare and Rural Development Initiatives
(FOSEWERD Initiatives)
P. O. Box 9016, Dodowa, Tanzania

Emmanuel Tambi
Forum for Agriculture Research in Africa (FARA)
PMB CT 173, Accra, Ghana

Solomon Bangali
Forum for Agriculture Research in Africa (FARA)
PMB CT 173, Accra, Ghana

Citation
Msaki Mark M., Tambi Emmanuel, Bangali Solomon
FARA (2015). State of Knowledge on CSA in Africa, Case Studies from Rwanda, Tanzania and Zambia
Forum for Agricultural Research in Africa, Accra, Ghana

ISBN 978-9988-2-3782-8

Acknowledgment

FARA and its partner Sub Regional Organisations (SROs) wish to thank the Norwegian Agency for Development Cooperation (NORAD) for providing the necessary funds for the case studies. Further thanks go to all those who provided information or assisted in data collection. We are particularly grateful to the Agricultural Policy Research Network (APRNET) and CORAF/WECARD for their support in terms of information provided to the authors. Most importantly the authors appreciate the various country focal persons in the different countries that provided information on which this report is based. These include researchers, farmers, policy makers and Civil Society Organizations (CSOs) and Farmers Organizations engaged in agriculture and rural livelihood activities.

Foreword

The evidence of climate change such as rising temperature and changes in precipitation is undeniably frequent in recent years with impacts already affecting our ecosystems, biodiversity and people. One region of the world where the effects of climate change are being felt particularly hard is Africa. With limited economic development and institutional capacity, African countries are among the most vulnerable to the impacts of climate change. The long-term impact of climate change on food and nutritional security and environmental sustainability is continuously gaining attention, particularly in Sub-Saharan Africa.

Africa depends heavily on rain-fed agriculture, making rural livelihoods and food security highly vulnerable to climate variability such as shifts in growing seasons. Existing technologies and current institutional structures seem inadequate to achieve the mitigation needed to adequately slow climate change effects, while also meeting needed food security, livelihood and sustainability goals. Africa needs to identify actions that are science-based, utilize knowledge systems in new ways, and provide resilience for food systems and ecosystem services in agricultural landscapes despite the future uncertainty of climate change and extreme events. It is imperative therefore that new modes of science-policy integration, transform land management and community action for food security as well as for conservation of biodiversity and the resource base upon which agriculture depends.

Climate Smart Agriculture (CSA) is one of the innovative approaches of sustainably increasing productivity of crops, livestock, fisheries and forestry production systems and improving livelihoods and income for rural people, while at the same time contributing to the mitigation of the effects of Climate Change. CSA combines the improvement of social resilience with the improvement of ecological resilience and promotes environment friendly intensification of farming systems, herding systems and the efficiency of sustainable gathering systems. The increase in production boosted through CSA should be driven through adequate combination of technologies, policies, financing mechanisms, risk management schemes and institutional development. It is imperative therefore, that CSA should be embedded into identified development pathways, transforming food systems, landscapes, farming systems and practices adapted to communities to bring "triple wins" that enhance opportunities to increase agricultural productivity, improve resilience to climate change, and contribute to long-term reductions in dangerous green house gas emissions.

Although there are many research and analytical efforts to minimize the impact of climate change on agriculture and on livelihoods in Africa by various actors, there is however, no coherent documented state of knowledge of CSA practices in Africa.

FARA is aware that there are ongoing successful CSA practices across Africa.

Identifying and documenting successful CSA practices has been a challenge. FARA with support from the Norwegian Agency for Development Cooperation (NORAD) undertook a series of studies in twelve countries to generate data and information on CSA issues that can be used to support evidence-based CSA policy and programme design, and performance monitoring. This report presents the state of CSA knowledge as it exists inRwanda, Tanzania And Zambia.

It is expected that the knowledge and information contained within will support future efforts aimed at addressing climate change issues in the three countries.

Yemi Akinbamijo
Executive Director, FARA

Table of Contents

List of Tables

List of Plates

Acronyms and Abbreviations

APRNET	Agricultural Policy Research Network
ARI	Agriculture Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa (corresponding to 3 geo-ecological zones).
ASIP	Agriculture Sector Investment Program
AU	African Union
CAADP	Comprehensive Africa Agriculture Development Programme
CARE	International Cooperative for Assistance and Relief Everywhere
CCARDESA	Centre for Coordination of Agricultural Research and Development for Southern Africa
CC	Climate Change
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultural Tropical (International Center for Tropical Agriculture)
CIFOR	Center for International Forestry Research
CIMMYT	International Maize and Wheat Improvement Center
CIP	Crop Intensification Program
CIRAD	La recherche agronomique pour le développement
COMESA	Common Market for Eastern and Southern Africa
CSA	Climate Smart Agriculture
CSC	Ecological Monitoring Centre
EU	European Union
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization of the United Nations Statistics Department
FARA	Forum for Agricultural Research in Africa
FMARD	Federal Ministry of Agriculture and Rural Development
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture

IPCC	Intergovernmental Panel on Climate Change
ISFM	Integrated Soil Fertility Management
NAFSIP	National Agriculture and Food Security Investment Plan
NAIP	National Agricultural Investment Plan
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NARF	National Agricultural Resilience Framework
NASRO	North African Sub-Regional Research Organization
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for Development Cooperation
PRSP	Poverty Reduction Strategy Paper
RARC	Rokupr Agricultural Research Centre
SADC	Southern African Development Community
SLM	Sustainable Land Management
TAFSIP	Tanzania Agriculture and Food Security Investment Program
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WFP	World Food Programme

Executive Summary

Agriculture in East and Southern African is highly vulnerable to climate change and urgent actions are needed to combat its impacts and maintain or improve food security and livelihoods. The Climate Smart Agriculture (CSA) approach offers an opportunity of achieving triple wins of food security, adaptation and mitigation. The Forum for Agricultural Research in Africa (FARA), with support from the Norwegian Agency for Development (NORAD), recognizing the need to promote CSA in Africa embarked on a baseline survey to determine the status of CSA in Africa.

The primary purpose of the study was to identify and document the best practices of CSA that can be shared and scaled up and out in order to mitigate the effects of climate change on food security and livelihoods. The specific objectives were to:

(i) Identify, document and collect data and information on successful climate-smart agricultural practices for scaling up and out;

(ii) Document and collect data and information on policies that promote climate-smart agriculture;

(iii) Identify existing gaps and investment opportunities where CSA can intervene within the CAADP framework;

(iv) Determine the drivers, challenges or opportunities that may facilitate or hinder scaling up and out of CSA practices in West Africa; and

(v) Ascertain the priority crops and livestock that are suitable for CSA practices across different agro-ecologies in Africa.

Data was collected from desk studies and rapid field surveys involving (i) key informants as experts in the field of climate change and CSA, and (ii) review of literature on the socio-economic characteristics of African farmers, food production systems, climate change adaptation and mitigation and policies. Rwanda, Tanzania and Zambia were selected as study countries representing East and Southern Africa's Agro-Ecological Zones (AEZ) and Farming systems. Key messages emanated from the survey:

- Temperatures and water are main reasons for stress in agriculture production. While temperatures have been increasing, annual rainfall has been fluctuating but overall, has declined. Such trends, in general, have negative impacts on agriculture.

- Farmers in East and Southern Africa in all the agro-climatic zones are poor, and mainly illiterate, operators of rain fed farming systems, cultivating small farms (<1- 5 hectares) with soils of low fertility, and producing very low crop yields.

- Women form the majority of workforce in agriculture, though they have some limitation in owning the land. Access to agricultural credit and markets by both male and female farmers is very limited. Gender considerations must be taken into account in all aspects of scaling up

and out of CSA.

- The adaptive capacity of African farmers is low as a consequence of the poor socio-economic circumstances, harsh biophysical environments, low technology, and poor infrastructure that they have to contend with.

- Best Bets and success stories of CSA are available in Eastern and Southern Africa. They consist of technological options based on the principles of sustainable land management; risk management approaches such as seasonal weather forecasts; index-based crop insurance, safety nets; and a participatory climate smart village approach which can be replicated in similar situations.

- Improved high yielding and short duration crop varieties tolerant to stresses such as drought, floods, salinity and disease are suitable for CSA. Improved varieties of important staples such as sorghum, millet, rice, maizehave been developed from collaboration between national and international research organizations.

- Under climate change, livestock system will require technologies leading to improved livestock, production resources, genetic potential of livestock breeds and control animal diseases.

- Policies specifically on CSA are lacking at national, sub-regional, and regional levels. However some National Agricultural Investment Plans (NAIPs) include climate change, adaptation or CSA components thereby providing entry points for promoting CSA.

- Enabling policy environments for CSA to thrive should be developed by governments through accommodation of multiple objectives of enhancing productivity, adaptation (resilience) to climate change and mitigation of greenhouse gas emissions.

- Similarities in Eastern and Southern Africa's countries agro-ecological zones indicate good feasibility for up-scaling, out-scaling and adoption of CSA through information sharing including Information Communication Technologies (ICTs), and replication of lessons from research and policy.

- Scaling up and out of CSA Best Bets can be achieved through provision of incentives for farmers; alignment of CSA with appropriate economic, health, social, energy, infrastructure policies; and mainstreaming of CSA into NAFSIPs.

- National, regional and international partners (NGOs, UN Agencies, CGIAR, AU-NEPAD, SADC, EAC, FARA, ASARECA, CCARDESA, NASRO, World Bank, AfDB, and donor agencies) are crucial for successful research and development of CSA, in a situation where governments cannot fully fund national budgets.

- FARA should lead the process to sensitize governments to have CSA-responsive policies and respond to regional and continental policies and agreements.

- Research and development should improve productivity of present CSA technologies to mimic that of the green revolution and enable farmers to adapt to and mitigate climate change.

- Research should be directed towards developing methods for quantifying carbon under different farming systems and CSA technologies to allow farmers demonstrate their contribution in mitigating climate change so as to participate in carbon markets.

It can be inferred from the findings of the study that opportunities exist to promote CSA through addressing the socio-economic and structural constraints facing African farmers. The key is to ensure effective flow of CSA information through highly skilled extension staff with targeted information packages. Investments are required to develop CSA technologies and related research, set-up communities of practice such as CSA villages, cushion farmers from the risks and uncertainties of investment in long-term agricultural projects and to make upfront payments on CSA investments. There is a need for the coordination of efforts towards CSA through sharing lessons and linking farmers to markets. Governments will play a critical role in adoption of CSA through influencing policies and institutions that are key drivers to promoting CSA. Coordination is required to lobby African governments to achieve buy-in towards widespread promotion of CSA in Africa.

1. Introduction

1.1 Background

African technical and political leaders recognize the significance and need to address issues of climate change. One of the strategies adopted under Pillar I of the Comprehensive Africa Agriculture Development Programme (CAADP) is the adoption of sustainable land and water use practices in order to contribute to CAADP's 6% annual growth of agriculture. Embedded in this strategy is the adoption of Climate Smart Agriculture (CSA) as a combined policy, technology and financing approach to achieve sustainable agricultural development under climate change. CSA implies agriculture that sustainably enhances productivity and resilience (adaptation), reduces or eliminates greenhouse gases (mitigation), and enhances achievement of national food security and development goals (FMARD, 2014). By incorporating climate change adaptation and mitigation into agricultural development planning and investment, African will be able to sustainably increase agricultural productivity and enhance resilience for reduced food insecurity and poverty. In direct response to the rural communities' concerns, climate smart agriculture can minimize the effects of extreme rain conditions (drought or floods) thereby stabilizing production.

The successful implementation of workable CSA policy and programmes is one of innovative approaches of sustainably increasing productivity of crops, livestock, fisheries and forestry production systems as well as improving livelihoods and income for rural people while at the same time contributing to the mitigation of the effects of climate change. CSA combines the improvement of social resilience with the improvement of ecological functions and promotes environment friendly intensification of farming systems, herding systems and the efficiency of sustainable gathering systems. The increase in production boosted through CSA should be driven through adequate combination of technologies, policies, financing mechanisms, risks management schemes and institutional development. Therefore, CSA should be embedded into identified development pathways, transforming food systems, landscapes and farming systems and practices adapted to communities. There are a wide range of agriculture-based practices and technologies that have the potential to increase food production and the adaptive capacity of the food production system, as well as reduce emissions or enhance carbon storage in agricultural soils and biomass. However, even where such synergies exist, capturing them may entail significant costs, particularly for smallholders in the short-term.

There has been no coherent baseline data showing where successful CSA is practiced and on policies to stimulate its sustainability and practice. While there may have been some research and analytical efforts[1] to understand local circumstances and driving factors for enhanced and sustained adoption of CSA, there is no systematic

[1] Some of the organizations working on CSA in Africa include AUC, NPCA,

documentation of success stories covering the Africa's agro-ecological zones that can provide baseline data for identifying possible areas of CSA research, policy interventions and actions.

This report is drafted in response to the intention of The Forum for Agricultural Research in Africa (FARA), with support from NORAD, and in collaboration with the SROs (ASARECA and CCARDESA), to document information on Climate Smart Agriculture (CSA) practices that can be shared and scaled up. The report provides information that can be used to support evidence-based CSA policy, programme design and performance monitoring as a means of accelerated scaling up and out of CSA.

2. Methods

2.1 Inception Meeting

The CSA review report for Rwanda Tanzania and Zambia has been part of the FARA Regional initiative to carry out the Baseline for CSA in Africa. An inception meeting between the consultants from various sub regions and FARA team took place on 29 May 2014. The purpose of the meeting was to obtain common understanding of the terms of reference and to develop tools for collecting data for this report.

2.2 Sources of Data

Primary and secondary data were used in the study. Primary data was collected from key informants such as experts in the field of climate change and CSA using a questionnaire and / or through rapid participatory surveys and from secondary sources. Secondary data was obtained through the review of literature on the socio-economic characteristics of African farmers, food production systems, climate change adaptation and mitigation as well as on policies and national plans.

For the baseline survey to be conducted, the survey engaged the review of literature and interviews to Key Informants. Literature review involved accessing information from national and international sources and reviewing existing grey and published literature on adaptation to climate change, mitigation of GHG emissions, CSA and policies related to climate change, food security and rural development. Key informant interview involved policy-makers, researchers and farmers organizations involved in designing and implementing agricultural development and climate change adaptation policies in the studied countries.

2.3 Study Area

The study area included the major Agro-Ecological Zones of East and Southern Africa as established from existing literature (http://www.ipipotash.org/fr/eifc-image/2012/32/6/map2).

The main Agro-Ecological Zones of interest for each region were the arid/ semi-arid, sub-humid and humid AEZs of East and Southern Africa. Rwanda, Tanzania and Zambia are a fair representation of the region to obtain baseline information on the state of CSA (see Table 2.1). These countries were also selected based on their vulnerability to climate change as shown in Table 2.2. Region wise, while Rwanda and Zambia are aligned to ASARECA and CCARDESA. Tanzania is a member of Both ASARECA and CCARDESA.

Table 2 1 The Agro-ecological zones of the selected study countries

SROs/ FARA Geo-ecological zones	Major agro-ecological zones (AEZ)						
	Arid/ Semi-arid	Sub-humid	Humid	Highland Arid	Highland semi-arid	Highland sub-humid	Highland humid
						Rwanda	Rwanda
ASARECA	Tanzania	Tanzania	Tanzania	Tanzania	Tanzania	Tanzania	Tanzania
CCARDESA	Zambia Tanzania	Zambia Tanzania	Tanzania	Tanzania*	Zambia Tanzania	Zambia Tanzania	Tanzania
Farming systems							
Rwanda	High Land perennial						
Tanzania	Agro Pastoral ;Maize Mixed ;Highland Perennial ;Root and Tubers ; Forest Based						
Zambia	Agro Pastoral, Maize Mixed						

2.4 Data Collection

Data and information collected included adaptation and mitigation measures in use, case outlines of successful CSA, observed temperature and rainfall, vulnerability to climate change and impacts, socio-economic and demographic characteristics of farmers, crop yield, indicators of development and governance, national policies and strategies, Data were collected with reference to the 2013 agricultural production season which is considered a baseline year for this report except as otherwise specified.

However, the limitation of the study was due to the scoping nature of the study that did not provide sufficient data for statistical analysis. Also, it was not feasible to obtain identical data sets from each of the selected countries.

Table 2.2 : Countries and farmers vulnerability to climate change

	RWANDA	ZAMBIA	TANZANIA
Country's concerns about climate change	HIGH High density population zones are currently characterised by overexploitation of lands and a vegetal cover severely altered. Erosion and landslides processes are advanced. The agriculture sector accounted for 43% of GDP and sustains almost 90% of the population and depends on rains The increased frequency of natural disaster decreases the country's food availability. Lands of 16 – 40 % slope cover nearly 45 % of the country. Moreover, the country loses approximately 1.4 million tons of fertile soils per year due to soil erosion Food security index score (Low 34.2) GFSI (2014) widespread poverty	HIGH widespread poverty..... about 80 % are rain-fed while agriculture conribute at about 20 % of gdp (fanpran 2010) over 60 % earn living through agriculture, (undp zambia 2010) Food security index score (Low 32.6) GFSI (2014)	HIGH High levels of poverty and illiteracy. Income and employment to over 80% of the population – rainfed Tanzania's economic base is dependent on the use of natural resources, rain-fed agriculture and biomass for household energy Food security index score (Low 29.9) (GFSI 2014)
Poverty level	The population living below poverty line is estimated at 60%, of which 66% live in rural areas. About 43% of the population are in a situation of extreme poverty.	(PRSP) indicates that about 73 percent of Zambians are classified as poor. The level of poverty in the rural areas where 64% of the population resides is about 83%.	28.2 % below poverty line (HBS 2012)
Farmers access to credit	POOR Less than 2 % of credits goes to rural sector (Papias and Gamesin 2009) – muhonganyire et al 2013.	POOR Taylor et al. (2009) Zambia's market for agricultural finance is dysfunctional.	POOR (60% no access) Finscope 2009
Farmers access to markets	POOR (IFAD, 2014)	POOR (Chapoto and Jayne 2011)	POOR (IFAD 2010)
Farmers access to extension service	15 %. – 351 - AA	23 %. – 354 – AA	10 – 16%. – 352 – AA
Farm sizes	0.6 ha (http://www.minagri.gov.rw/index.php?id=578)	1 – 3 ha (Makoyi, 2013)	Small scale (x < 5ha), medium scale (5 – 20ha) (Chikowo 2014)

3. Climate change and its implications for agriculture and livestock production

The section presents information on the changing pattern of rainfall and temperatures across Rwanda, Tanzania and Zambia based on various modelling scenarios. Temperature and rainfall changes are key climate drivers calling for enhancing Climate Smart Agriculture.

3.1 Climate change in Rwanda

There has been a significant increase in temperature of almost half a degree per decade (0.47°C), taking average annual temperature towards 22°C in 2010. This trend is more rapid than the global observed average reported in the most recent IPCC report of between 0.19 and 0.32°C per decade for 1979-2005 (Trenberth et al., 2007). No significant trend is found for rainfall over the period 1931-1990 but annual rainfall anomalies of up to approximately ±25% have been observed over the 1961-90 average. There is a high interannual variability for rainfall across Rwanda (Conway, 2002).

Modeling of the future Climate of Rwanda:

Climate Projections show increases for temperature, and precipitation. Median projections of temperature show a rise of around 1°C by the 2020s, 1.5-2°C by the 2050s and 2-3°C by the 2050s. Median projections for precipitation show up to 7% increase by the 2080s under A2 (Conway 2002). Changes in precipitation are more uncertain than temperature. Although the intensity, frequency and spatial distribution of precipitation are unknown, all the climate model scenarios show that average rainfall regimes will change, ranging from positive and negative anomalies across the models. The majority of the projections indicate that average annual rainfall will actually increase, particularly in some seasons, indicating a potential strengthening of the rains which is important in relation to flood risk.

3.2 Climate change in Tanzania

Rainfall patterns in the country are subdivided into: tropical on the coast, where it is hot and humid (rainy season March-May): semi-temperate in the mountains with the short rains (Vuli) in November-December and the long rains (Masika) in February –May: and drier (Kiangazi) in the plateau region with considerable seasonal variations in temperature. The mean annual rainfall varies from 500 millimeters to 2,500 millimeters and above. The average duration of the dry season is 5 to 6 months. However, recently, rainfall pattern has become much more unpredictable with some areas/ zones receiving extremely minimum and maximum rainfall per year. Monthly minimum and maximum temperatures over the last 30 years (between 1974 and 2004) show upward trend at the analyzed meteorological stations mostly associated with the months of January, July and December (NAPA TANZANIA, 2007).

Modeling of the future Climate of Tanzania:

Climate projections show that mean temperatures will increase throughout the country particularly during the cool months by 3.5^{o}C while annual temperatures will increase between 2.1^{o}C in the North Eastern parts to 4^{o}C in the Central and Western parts of the country. Predictions show that the mean daily temperature will rise by 3^{o}C – 5^{o}C throughout the country and the mean annual temperature by 2^{o}C – 4^{o}C. There will also be an increase in rainfall in some parts while other parts will experience decreased rainfall. Predictions further show that areas with bimodal rainfall pattern will experience increased rainfall of 5% – 45% and those with unimodal rainfall pattern will experience decreased rainfall of 5% – 15% (NAPA TANZANIA, 2007).

3.3 Climate change in Zambia

Climate of Zambia can be distiguished for three regions based on their respective agro-ecological zones of semi-arid (I), highland semi-arid (II) and humid (III) where region III is a higher rainfall area followed by region II and lastly region I with consistently lower rainfall area. Region I is consistently experiencing climatic hazards in terms of droughts and water scarcity. Although the rainfall trends may not be that clear, there is a general tendency of rainfall declining and shifting towards dryness over the last decades (NAPA ZAMBIA, 2007).

Modeling of the future Climate of Zambia:

The mean temperature scenarios for all the Regions show a similar trend of increasing mean temperatures for the period 2010 to 2070 of about 2^{o}C (24.5^{o}C - 26^{o}C). The HADCM3 Global Climate Model (GCM) was used show a general increase in rainfall in the three regions of the country (NAPA ZAMBIA, 2007).

3.4 Climate change and cropping systems

Climate change on cropping systems in Rwanda

The typical rural settlement is much dispersed and encroaches often on productive agricultural lands. The population living below poverty line is estimated at 60%, of which 66% live in rural areas. About 43% of the population are in a situation of extreme poverty. High density population zones are currently characterised by overexploitation of lands and severe land use cover change. Erosion and landslides processes are advanced. The economy of Rwanda is mainly agricultural. In 2002, the agriculture sector accounted for 43% of GDP and sustains almost 90% of the population. The agricultural use depends almost exclusively on the quality of the rainy season, which makes the country particularly vulnerable to the climate change. The increased frequency of drought periods, floods, landslides and erosion presently observed considerably decreases the country's food availability (REMA, 2011).

Extreme weather events (high temperatures, drought, floods, heavy erratic rains, humidity) will continue to affect Rwanda's agricultural sector in several ways. The southern and eastern regions situated along Akagera and Akanyaru valleys are more sensitive to current climate variability and future climate change if observed tendencies continue. These vulnerable regions receive migrating populations from regions with high population density and the natural capital has reached a critical level of degradation. These migrating populations in search of new agricultural lands and pastures are already presenting high economic and social vulnerability. Climate change is increasing hazards resulting from crop loss or failure, undermining Government capacity to deliver on agricultural outcomes in the MDGs and Vision 2020 and will increase social vulnerability of poor households.

With regards to vulnerability of climate change in Rwanda, the most vunerable zones are categorised into 2 majorzones,such as East /South East and North / Centre/ West and in East (Umutara, Kibungo) and South East (Bugesera et Mayaga). The phenomenon is prolonged absence of precipitation leading to drought potential that cause negative effects such as drops in agricultural production and lack of water and food produce for the populations, decrease of levels of lakes and rivers, lack of pasture for domesticated animals and soil and forests degradation.

In the North (Gisenyi, Ruhengeri and Byumba) and Centre/West (Gitarama, Kibuye and Gikongoro) the phenomenon being high precipitation and landslides and landslips. This situation is expected to lead into risks of floods, Soil degradation & impoverishment, destruction of plants in swampy and river zones and destruction of infrastructures in low zones. Among the anticipated effects are environmental degradation and disappearance of rare species, famines, human loss, economic loss, erosion and threatened human and animal lives and disturbed transport and threat to economic and commercial sectors (NAPA RWANDA, 2006).

Climate change on cropping systems in Tanzania

Agriculture (including livestock production) is the dominant sector in Tanzanian economy, providing livelihood, income and employment to over 80% of the population. It is the main source of employment and livelihood for more than two thirds of Tanzanian women. It is an important economic sector in terms of food production, employment generation, production of raw materials for industries and generation of foreign exchange.

An illustration of climate change risks to the country is the Gross Domestic Product (GDP) which in real terms grew by 6.8 percent in 2005, compared to 6.7 percent in 2004, however this was lower than the targeted growth of 6.9 % and the drop was attributed to severe drought which affected most parts of the country in the last quarter of last year leading to severe food shortages, food insecurity and hunger.

Climate change thus has undermined national efforts to attain the Millennium Development Goals (MDGs) and places poverty reduction efforts in jeopardy. The loss of human, natural, financial, social and physical capital, caused by the adverse impacts of climate change, especially severe droughts and floods, among many other disasters, are of great concern to Tanzania.

Since Tanzania's economy is largely dependent on agriculture, it is deemed that sustainable development can be achieved when strategic actions, both short term and long term are put in place to address climate change impacts on agriculture and other key economic sectors. Climate change effects have been a threat mainly to the agrarian population that still depends on subsistence agriculture for their daily livelihood. The major causes of vulnerabilities at village, district and national levels is climate change associated with prolonged heavy rainfall or drought. According to the (Vulnerability Assessment Report (VAR), the top four hazards in the country are; epidemics, drought, pest/vermin/plant diseases, and floods. These high ranked hazards have also been observed as commonly occurring in a period of less than five years, and have a positive correlation with the climate change observed throughout the country within the same time period (PMO and UCLAS, 2003).

Various threats that are posed by climate change have their negative consequence on Climate Smart Agriculture in Tanzania. For instance, the major basins in Tanzania which includes Rufiji, Pangani, Ruvu, Great Ruaha, Malagarasi, Kagera, Mara, Ruvuma, and Ugalla River Basins are critical for fishing and traditional farming irrigation systems. The INC shows that the increase in temperature between 1.8°C – to 3.6°C in the catchments areas of River Pangani in the North and North East of the country, will lead to a decrease of 6-9% of the annual flow of the river. Deforestation rate was estimated to be 91, 276 hectares per year in 2002. The main reasons for deforestation include clearing for agriculture and settlement, overgrazing, wildfires, charcoal burning and over-exploitation of wood resources for commercial purposes. The biomass energy resource, which comprises of fuel-wood and charcoal from both natural forest and plantations, accounts for 93 per cent of total energy consumption (NAPA, Tanzania 2007).

With increase in temperature and reduced rainfall as well as change in rainfall patterns, average yield of maize will decrease by 33% country wide. Furthermore, yield of the same crop will decreases by up to 84% in the central regions, 22% in Northeastern highlands, 17% in the Lake Victoria region, and 10 – 15% in the Southern highland. In the other hand, coffee production is projected to increase by 18% in bimodal rainfall areas and 16% in unimodal rainfall areas as a result of temperature increase of 2-4°C.Cotton yields are projected to decrease by 10%-20% due to the impact of pest and diseases (NAPA TANZANIA, 2007).

Climate change on cropping systems in Zambia

Poverty in Zambia is wide spread, with 73% of the population living below the poverty line. Over 60% of Zambians live in rural areas, with the majority depending on subsistence rain-fed agriculture, and relying on a single maize harvest for their livelihoods. This makes them very vulnerable to climate related natural calamities and disasters, such as floods and droughts, which directly affect agricultural productivity. The current agricultural practices used are are no longer sustainable in the face of the limitations imposed by climate change, and there is urgent need for adaptation to avoid food insecurity, malnutrition, diseases and worsening of the condition of people living with HIV.

Historically, Zambia has been ravaged by droughts and floods but in recent decades the frequency and severity of these climatic hazards have increased. In the last seven years of this decade Zambia has had to endure droughts in the rainy seasons of 2000/01, 2001/02 and 2004/05 while floods have occurred in 2005/06 and 2006/07. The impacts of these droughts/floods have included widespread crop failure/loss, outbreaks of human and animal diseases, dislocation of human populations and destruction of property and infrastructure. In 2004/05 and 2006/07, the affected population sizes were 1,232,661 and 1,443,583 persons, respectively. Additionally shifts have been observed in the onset and withdrawal of a single season, resulting in decreased length of the agricultural growing season.

All critical economic sectors are extremely vulnerable to adverse effects of climate change as induced by global warming. Droughts, floods and to some extent extreme temperatures are the key climatic hazards in Zambia. Shortening of the growing season and dry spells within the growing season have also been mentioned to be devastating especially for crops. The contribution of the key sectors to the attainment of the national goals as prescribed in the PSRP, MDGs, and FNDP are thus in jeopardy (NAPA ZAMBIA, 2007)

Assessments that were undertaken as part of the NAPA process indicate that climate change will increase vulnerability especially in arid regions, which typically correspond to Agro-Ecological Regions (AER) I and II in Zambia. The NAPA has highlighted that areas suitable for staple crops, such as maize production are likely to reduce by more than 80%. At the national level, yield changes and other impacts under climate change scenarios suggest frequent shortages of grain. Such deficits could result in severe yield decrease for specific crops such as maize. Based on a CO_2 doubling scenario in these regions, some estimates predict a yield reduction of approximately 66% under rain-fed conditions but only about 16% under irrigated conditions. Currently, less than 5% of arable land in Zambia is irrigated. With changes in rainfall patterns, the average length of the growing season length for maize is also likely to become shorter, with models predicting an approximate reduction in the length of the season of 20%. From an agro-climatic perspective, maize (the main national staple) is already somewhat marginal in AER I, as annual rainfall is commonly insufficient for the crops sown. While agricultural systems are already quite close to the limits of their coping ranges, simulations of future climate change in AEZ I show that maize yields are likely to fall even further under both rain-fed and irrigated conditions (NAPA, ZAMBIA 2007). Drought, flood, extreme heat and shorter rain seasons are main threat to agriculture production in Zambia.

3.5 Climate change and livestock production systems in selected

One of the few studies is that of Thornton et al., (2006) who projected drop in length of growing period (LGP) that will negatively impact both livestock and crop systems with serious implications for food security. The impacts in Rwanda, Zambia and Tanzania is as follows;

Climate change and livestock production systems in Rwanda

Climate vulnerability is majorly found in the area of livestock and fish farming. According to climate scenarios for Rwanda, air temperatures will increase by 1 to 3°C by the year 2100. This shall have several follow on implications such as displacement of wet and dry seasons and therefore displacement of livestock in the eastern region of the country in search of pasture and water; drought leads to dehydration causing the fatigue of livestock and the occurrence of respiratory diseases, foot rot in the northwest of Rwanda with higher rainfall and decrease in milk production resulting in the decrease of sources of income for the population. Important overland runoff (resulting from drying out) on slopes under cultivation and overgrazing causing high sedimentation in lakes used for fishing. Also increased temperatures leading to high surface evaporation and evapotranspiration rates, coupled with reduced rainfall leading to lowering water levels and drying of water sources. This will severely impact on livestock production and fish farming (NAPA Rwanda, 2006).

Climate change and livestock production systems in Tanzania

Climate change is expected to further shrink the rangelands which are important for livestock keeping communities in Tanzania. This shrinkage will be more aggravated by the fact that about 60% of the total rangeland is infested by tsetse fly making it unsuitable for livestock rearing and human settlements. Drought and rising temperature also leads to shrinkage of rangeland resources (water and quality and quality of forage) exacerbating conflicts between livestock keepers and farmers (NAPA Tanzania, 2007). Animal losses have been happening due to lack of rainfall and shrinkage of rangelands. Surveys show that existing number of cattle in Tanzania has already surpassed the normal carrying capacity in most of the northern areas. As a result, most livestock keepers are shifting their herd towards southern Tanzania in search for pastures.

Climate change and livestock production systems in Zambia

As temperatures rise, the cattle population is reduced. This scenario is related to the amount of rainfall; extreme temperatures which are asociated with droughts (less rainfall) and vice versa. Conversely, as the amount of rainfall increases, the number of animals also increased. This situation may be explained in relation to increased plant growth and the subsequent increased availability of pastures leading to good nutrition, enhanced immunity and productive capacity. Specifically, drought is linked to water shortages, reduced fish stocks, increase in diseases (affecting humans and animals), and increased soil erosion. Floods leads to loss of crop land and grazing ground, decline in fish catches and life loss (humans and livestock). Extreme heat have been leading to loss of life, increase in diseases, affecting animals, reduced fish stocks and decreased livestock feed (NAPA Zambia, 2007).

3.6 Implications for Markets, Finance and Policy

Change in length of growing period resulting from rainfall and temperature changes ultimately have implications for trade. Regional and international trade flow patterns for key agricultural commodities move from countries of higher agricultural yields and comparative advantage to countries of lower yields. Improved access to markets both locally and internationally would provide a driving force for increasing agricultural productivity. To counter predicted drop in agricultural production, financial support in the form of investments and smart subsidies for the poor, small scale farmers to enable them adopt CSA should be considered by governments. Currently, rural accessibility to finance has been poor to Rwanda, Tanzania and Zambia (Action Aid 2013; Muhongayirea et al., 2013; Finscope, 2009 and Taylor et al., 2009). Similarily, accessibility to markets is still in poor condition in Rwanda, Tanzania and Zambia (IFAD 2014; IFAD 2010 and Capoto and Jayne 2011). Appropriate policies should be in place to enable scaling and out of CSA.

3.7 Summary

Across the three countries, loss/reduction in crop yields, degradation of the ecosystem and loss of biodiversity were common feature for all zones. In the semi-arid areas (Zambia and Tanzania zones) there is very strong erosion and land degradation, reduction in land, lack of forage, reduction in numbers of livestock, incomes and labor force. Similarly, high population density and mountainous nature of land in Rwanda have been the reason behind erosion with similar consequences. Reductions in crop yield and increased pressure on the land have resulted into migrations and consequently frequent conflicts between farmers and livestock keepers. CSA must therefore deliver increased and stable yields as well as improved livelihoods through developing new CSA technologies and innovations, improving uptake of the improved technologies, and facilitating availability of safety nets and weather- based insurance schemes. It is imperative that efforts should be directed towards climate smart livestock technologies and management strategies that provide opportunities for farmers to enhance provision of rangeland resource to compensate for the reduction in ecosystem services resulting from climate change.

As food production systems will be affected by climate change, adoption of new climate resilient technologies is required for farmers to evade impacts of climate change. Several factors (bio-physical, socio-economic and institutional) can influence farmer's capacity to adopt new agricultural technologies and approaches including climate smart agriculture. Adaptation to climate change through CSA is possible only if farmers meet the minimum threshold levels in socio-economic and biophysical characteristics and obtain the necessary support from research in form of appropriate technologies and an enabling environment created through policies and institutions.

4. Successful Climate-Smart Agricultural Practices

4.1 Adaptation and Mitigation practices in use

A number of CSA technologies are in use in the different AEZ in Rwanda, Tanzania and Zambia. Climate Smart Agriculture needs to ensure not only resilience of agriculture in productivity but also adaptation and mitigation of climate change impacts. Proper management of all resources needed in agriculture such as soils, water, genetic resources, pest and disease control promote increased productivity, protect the environment, adapt to and mitigate climate change. However, levels of production, adaptation and mitigation to climate change vary from place to place and sometimes crop to crop. The major threat to agricultural in the countries surveyed is land and soil degradation such as soil structure destruction, decrease soil organic matter, nutrient mining and nutrient imbalances, reduced microbial activity and prevalence of pests, diseases, and weeds. The CSA best practices and technologies can thereafter be categorized as conservation agriculture, crop diversification and cropland management, soil and water conservation and erosion control, more resilient food crops and risk insurance, fodder development, rangeland management and integrating livestock and crops, soil fertility management and agro-forestry (Lengale, 2013). Table 4.1 summarizes the Climate Smart practices for agriculture for Rwanda, Zambia and Tanzania.

Adaptation/mitigation measures reported to be in use are: short duration crop varieties; vegetable production; integrated soil fertility management; soil and water conservation techniques, crop associations; use of animal manures, manure and fertilizer mix, use of pesticides; composting; restitution of crop residues to the soil; restoration of degraded lands; agroforestry; association of crops with legume tree; assisted natural regeneration; use of lowlands; small scale irrigation; agricultural mechanization andcloud seeding. In the livestock sector, they also include use of high yielding livestock breeds tolerant to stress, and mordern poultry production. In the sub-humid zone, the system of rice intensification is promoted. In both the sub-humid-humid zones, and the arid lands (fed by rivers) the main adaptation/mitigation measures reportedly in use include sunken beds / earth bunds *(majaluba)* farming; short duration and drought tolerant crops; adjusting of farming calendars; dry season cropping; increased processing of crop produce; increased processing of livestock produce; intercropping; crop diversification and multi-storey tree crop farming.

While Rwanda remains peculiar, as it does not have semi desert characteristics, the country is challenged differently. Rwanda, a country with highlands ranging from an average of 1,100 meters above sea level to an average of 2,200 meters above sea level in Birunga with slopes at varying gradients (some greater than 55 %) and high population have been challenged mainly by soil erosion (Verdoodt and Ranst, 2001). Furrows and ridges made against the slope (along the contour) with furrow upslope and ridge down slope conserve water and avoid soil erosion. The furrows which are used to trap rain water and are closed at the end to prevent water flow out of the furrow at the end of the furrows are suitable for inter cropping especially cereal and beans. However, the peculiar thing across the three countries is that similar methods have been useful across the three countries in areas with similar geo physical characteristics. Generally, contour farming is more effective in Tanzania in areas with slope of 4 to 6%, and all farm operations are done along the contour (Mati, 2007). The wide variation of AEZ has been key to determine the wide range of CSA practices in Tanzania, CSA practices works better in combination. Climate Smart Villages are a potential way to practice and of scaling out of best bet CSA practices.

Climate Smart Villages

Climate Smart Villages has been a method to practice and demonstrate Climate Smart Practices. Chololo Eco village, an initiative funded by EU to improve livelihood of the poor in an arid land of Central Tanzania has been showing good results in mitigation to climate change (chololoecovillage. wordpress.com, Kalumanga et al., 2014). The project has just entered phase II expanding for up scaling to two districts. Green and Smart Village in Rubaya, Gicumbi District, Northern Province of Rwanda has been engaged in controlling erosion, creating green jobs, increase access to energy, agroforestry tree planting, creating progressive terraces and improved cooking stoves. Schemes such as Sustainable Land Management and Environmental Rehabilitation Rubona Sector, Rwamagana, Eastern Province, have enabled build capacity to tackle major environmental challenges including: soil erosion, vital soil nutrient depletion, deforestation, and unsustainable agricultural practices and energy sources. Roof top rain water harvesting in high Density Areas, an initiative by Rwanda Natural Resources Authority (RNRA) of Kayonza, Eastern Province has been aiming to reduce surface runoff and improve the livelihoods of people and families through the multiple use of rainwater (FONERWA, 2014).

At Chololo Eco village, the automatic weather station (costing around 100 USD) has been key in gathering data to help farmers adapt to the changing climate. The weather station records temperature, rainfall, humidity, pressure, wind speed and direction. Every 30 minutes the data is transmitted wirelessly to a receiver in the nearby dispensary, and then downloaded periodically to a laptop by USB cable as a spreadsheet, enabling charts to be easily created for analysis.

Economic adaptation to climate change has potential for farmers to increase productivity. In Chololo Eco village, leather tanning and making leather products have made the community have big stake in the value chain, (see Table 4.1) creating employments and earning income letting them out of poverty (chololoecovillage. wordpress.com, Kalumanga et al., 2014). Just as it is with the production of biogas (Energy adaptation to climate change), making livestock production profitable is necessary towards the promotion of total factor productivity in farming business, a component necessary for success in CSA .

Plate 4.1 Tanning leather and processing products in Chololo Eco - Village

Table 4.1 Successful CSA Practices in Rwanda, Tanzania and Zambia

INITIATIVES	COUNTRY	EFFECT
Alley cropping (with *C. spectabilis* hedgerow shrubs Cassia) than grown in control.	Rwanda	Significantly increased the maize yields from 666 kg/ha to 912 kg/ha; beans yields from 444 to 700 kgs/ha and sorghum from 1570 to 2180 kg/ha
Conservation agriculture involving terracing on the hillsides improving the soil on the land under cultivation Provided farmers with lime Providing access to finance for inputs including fertilizers and seeds, and extension services. Managing water run off to reduce erosion developing irrigation system	Rwanda	90 kg of seeds for Irish potatoes, and I harvested 1,250 kg of potatoes. 7 times better. Farmers reported an increase in yields and income: more than 65 percent of the first potato harvest was sold in the market (after satisfying people's own food needs) whereas only 10 percent used to be sold in the past (WB 2010).
F. Albida with crops	Rwanda	Maize intercropped with *Faidherbia albida*, yields can be slightly over 2 times under canopy compared with outside the canopy. Impacts depend on crops, species, densities, and different conditions among other factors and the project aims to maximize the benefits (Muthuri trees for FS 2012)
Fertiliser microdosing increase profitability	Rwanda	Superb potential for fertilization of Irish potato (v/c ratios frequently >8) in about one-fourth of all communes. Good potential on sorghum (v/c ratios from 2-4) in 4 zones representing about one- fourth of communes. Good potential (v/c ratios generally 2-3) for maize in five zones represented in at least one-third of the communes; Fertilizer use was found to be profitable on **irrigated rice, horticultural crops** such as **cabbage** and on **inoculated soy-beans** in a limited number of zones Excellent potential (v/c ratios frequently > 3) for DAP fertilizer used on climbing beans in six zones; these zones are found in approximately one-third of Rwanda s communes;

INITIATIVES	COUNTRY	EFFECT
Green Smart Village, Rubaya - Gicumbi District, Northern Province of Rwanda	Rwanda	Controlling erosion, creating green jobs, increase access to energy, agroforestry tree planting, creating progressive terraces and improved cooking stoves.
Conservation farming, ripping is done during dry season (soon after harvest) using oxen or tractor	Zambia	Increased maize yield to 7.0 t/ha compared to 2.8 t/ha under conventional tillage in Zambia;
Agro-Forestry is using Musangu tree *(Faidherbia albida)*,	Zambia	Contributes to mitigation of climate change by above ground C sequestering of about 2.5 to 3.6 tons of carbon per hectare per year. Also, the practice increased maize yield from 2.8 ton/ha to 7 ton/ha (GoZ, 2007)
Timely Fertiliser Application	Zambia	Households that obtained fertilizer on time and used animal draft power or mechanical power in land preparation are more likely to find fertilizer use profitable than other groups of households located in the same district. (Govereh, et al., 2003)
In Karatu and Arumeru district of Tanzania, conservation farming, ripping is done during dry season (soon after harvest) using oxen or tractor	Tanzania	Higher maize yield (1.9 to 2.0 t/ha) than direct seeding with jab planter (No till) which gave 1.7 t/ha in Tanzania (Mkomwa, et al., 2011)
Ripping and cover crops [lablab and pigeon pea (Cajanus Cajan)] with neither inorganic nor organic fertilizers in Karatu, Tanzania	Tanzania	reported to increase maize yield over three years from 2.0 in the first year,to 7.2 in the second year and 4t/ha in the third year (Mariki, et al, 2011).
In Arusha and Njombe Tanzania, biogas plant construction and use implemented by Tanzania Domestic Biogas Program (TDBP)	Tanzania	Zero grazing livestock keeping is practiced reduced GHGs emission
Practiving Terraces alone in Arusha and Dodoma in Tanzania	Tanzania	greater average yields of maize in maize (1.3t/ha) than minimum tillage alone (0.8 t/ha) (Tumbo, et al., 2012)
Participatory soil fertility management was done by African Highland Initiative (AHI) project in Kwalei village, Lushoto, Tanzania	Tanzania	Increased N use efficiency through maximizing N uptake by crop and this is essential to achieve CSA
Participatory soil fertility management was done by African NAFAKA project for rice production in Kilombero and Wami valleys, Tanzania	Tanzania	Increased N use efficiency through maximizing N uptake by crop and this is essential to achieve CSA

INITIATIVES	COUNTRY	EFFECT
The MICCA project implemented CSA through conservation agriculture, agro forestry and crop rotation, in Western side of Mountain Uluguru	Tanzania	Reductions in GHG emissions
More Resilient Food Crops (Sorghum – Wahi, Hakika and Macia and Cassava) and Risk Insurance in Tanzania	Tanzania	Yield potential range of 1.5 to 4.6 t/ha compared to 0.98 t/ha for local varieties of sorghum and are resistant to Striga (ASARECA 2013; Moyo, et al., 2004). Improved cassava varieties are more resilient under harsh conditions such as poor climatic conditions especially in low rainfall and low fertility areas.
Improved cassava varieties (Lake Zone)	Tanzania	Resistant in Cassava Mosaic Disease (CMD) were released and about 27% of farmers in the Lake Zone adopted these varieties (Kavia, et al., 2007)
Diversification and Value Addition to Crop and Tree Products (Sclerocaryabirrea) is an indigenous fruit tree (IFT) in Tanzania	Tanzania	Fruiting within two years instead of the normal 10 to 15 years. Fruits from Sclerocarya trees are used to develop valuable products which can be traded in the local markets, urban centres and even internationally. Such products include a variety of cosmetic oils (selling up to USD 80
Okoa improved pearl millet (Chololo Eco village)	Tanzania	harvest rande between 200 – 570 kgs / acre as compared to local pearl millet (30 – 300kgs/acre)
Eary maturing sorghum (Chololo Eco village)	Tanzania	produced 520 kgs / acre as compared to tradition sorghum (220 kgs)
Improved sunflower (Chololo Eco village)	Tanzania	produced 210 – 390 kgs/acre compared to tradition sunflower 30kgs/acre- 290 kgs/ acre
Sunflower oil production (Chololo Eco village)	Tanzania	Impoved sunflower oil production 60 littres/acre up to 110 litres/acre as compared to traditional (3 litres/acre – 40litres/acre)

INITIATIVES	COUNTRY	EFFECT
Combination The use of Ox-drawn tillage eg Magoye Ripper, Soil water conservation measures, like contour ridges, fanya juu bunds, grass strips, and gully healing, the use of Farmyard manure; Optimal plant population; Intercropping and crop rotation (Chololo Eco village)	Tanzania	Average increase of yield sorghum 137 %; pearl millet 105 %; sunflower 252 % and sunflower oil 383 %
Chololo pits	Tanzania	Indigenous *in situ* rainwater harvesting, consisting of small pits of 22 cm diameter and 30 cm deep, dug along the line at 60 cm space between pits in a row and 90 cm between rows of pits. The chololo pits are made with soil bunds around the pit to help retain rain water, farm yard manure and compost, and 1 to 2 maize/sorghum/millet seeds can be planted per pit (Munguambe,2007). Chololo pits have been reported to be effective in heavy soils rather than loamy soils (Tumbo, et al., 2012).
Contour Bunds with vegetable cropping	Tanzania	Used on the steep slopes of Uluguru Mountain in Mgeta, where vegetable production is practiced. The success of contour bunds in Mgeta is due to physiographic characteristics – mountainous with very steep slopes (>40% slope) which are highly susceptible to soil erosion. Returns made possible while cultivating vegetable crop.
Sunken beds/earth bunds for low land rice cropping in Bahi, Manyoni	Tanzania	In Tanzania sunken beds/earth bunds known as *majaruba* is common rain water harvesting technology used in rain fed flooded rice production in semi – arid areas especially in heavy clay soils (Hatibu and Mahoo, 1999).
Breeding Mpwapwa breed (cattle) with local breeds to improve genetic potential Improve productivity, livestock health and feeding improved	Tanzania	Improve genetic potential in Chololo Eco village Doubled milk poduction a day (from 1.5 liters to 4 liters a day). Also improved resistance to tickborne and worms, Reduced time to to first mating livestock management and disease

INITIATIVES	COUNTRY	EFFECT
Blended goat bucks (Chololo Eco village)	Tanzania	Blended goats have been shown to produce up to 28 kg at 72 weeks, double the weight of local breeds, improved milk production, compared to 6 – 13 kg carcass weight of local breed, who grow slowly and who provides milk to offspring.
Improved bee hives in sunflower fields (Chololo Eco village)	Tanzania	Modern bee hives produces 5 litres of honey per beehive, over three times as much as their traditional hives. At their best, the modern beehives can produce more than 20 litres of honey per year. Concurrently, increase sunflower yield by 30% through improved pollination.
Improved chicken (Chololo Eco village)	Tanzania	Crossbreds produce 3-4 times more eggs and weigh twice as much (2.5-3 kg) as the local birds. Local breed grow to 1.5kg and lay only 40 eggs per year.
Leather tanning and making leather products (Chololo Eco village)	Tanzania	Converting the value of the skin from 1 EURO to 20 EURO available at farm gate.
Energy saving cooking stoves, and low cost domestic biogas plants (Chololo Eco village)	Tanzania	Reduces deforestration, halve the amount of wood needed to cook, reducing pressure on forest resources, saving women time and effort, and reducing harmful smoke homes.
Solar Power (Chololo Eco village)	Tanzania	Reliable availability of water. The price of water has gone down from 50 TAS in the past to 25 TSh per bucket. No frequent breakdowns, no repairs.
Rain Water Harvesting (Chololo Eco village)	Tanzania	Water harvested (from roofs & sub-surface and sand dams) capture thousands of tons of water every year.
Extension services (ie., tick & diseases control) (Chololo Eco village)	Tanzania	Controling livestock diseases
Fish ponds (Chololo Eco village)	Tanzania	Seasonal activity, with farmers filling their ponds, during the rainy season when water is plentiful, stocking with fingerlings, harvesting adult fish at around 4 months, then draining their fish ponds during the dry season. Once harvested, the fish keepers are using the water in their fishponds to irrigate trees and for other activities around their homestead.

INITIATIVES	COUNTRY	EFFECT
Automatic weather station (Chololo Eco village)	Tanzania	Gathering data to help farmers adapt to the changing climate.
Fertiliser use	Tanzania	Contribute to 35 % - 40 % of yield increase (Turuka and Kilasara, 2001, SAGCOT, 2011)
Integrated use of Farm Yard Manure (FYM) and Nitrogen (N) and Phosphorous (P) (Uyole, Mbeya)	Tanzania	Applying N at 20kg/ha; P at 20kg/ha and FYM at 4t/ha produces 7.1 t/ha of maize grain compared to 4.0 t/ha when same rate of NP used alone and 2 t/ha when no fertiliser used (Lyimo and Temu, 1992)
High in-organic N content of soils under fallow and increase in maize yields after fallowing Banzi, et al., (2004)	Tanzania	*A. polyacantha* kg N ha-1 82 Yield t ha-1 3.2, L. leucocephala kg N ha-1 87 Yield t ha-1 2.8 *A.nilotica* kg N ha-1 73 Yield t ha-1 2.5 Natural fallow kg N ha-1 51 Yield t ha-1 2.0 (Banzi et al., 2004)
Conservation of standing hay during rainy season and open up for grazing at the peak of dry season *(Ngitili)*.	Tanzania	Rehabilitation of degraded rangelands whether through private *ngitili*, or communal *ngitili* in the Sukumaland improves soil physical and chemical properties and herbaceous composition and basal cover (Selemani, 2015)
Ngolo pits and ridges	Tanzania	With shifting pits and ridges, burying dry grasses, ngolo fields mantains soils matured. Ngolo farms remain highly fertile, highly productive, conserve water and and non eroded at steep slopes of Matengo lands, Southern Tanzania (Kato. 2001)

As presented in Table 4.1, Successful Climate-Smart Agricultural practices are present in all countries engaged in the survey. Climate Smart Agriculture needs to ensure not only resilience of agricultural in productivity but also adaptation and mitigation of climate change impacts. Up scaling and out scaling of Climate Smart Agriculture should maintain to see improvement in productivity, adaptation and mitigation to climate change.

5. Policies and Actions to Promote Climate Smart Agriculture

5.1 Regional Policies Supporting CSA

There are a number of institutions with policies that promote CSA across Rwanda, Tanzania and Zambia. This includes regional blocks such at the East Africa Community (EAC), Common Market for East and Southern Africa (COMESA), and Southern Africa Development Cooperation (SADC). Following such regionalization, CSA issues are addressed through the agriculture R&D unit of such blocks. To executive this objective better, SROs for FARA; ASARECA and CCARDESA should partner with other agencies to promote CSA in Africa. The Forum for Agricultural Research in Africa (FARA), in response to NEPAD's request by developed the Framework for African Agricultural Productivity (FAAP). The purpose of FAAP is to guide stakeholders in African agricultural research and development to meet the objectives of CAADP pillar IV with regard to:

(i) strengthening Africa's capacity to build human and institutional capacity;
(ii) empowering farmers, and
(iii) strengthening agricultural support services.

FAAP work at the continental, sub-regional and national level aims to increase agricultural growth and to complement the other three pillars of CAADP. The role at sub-regional levels such as ASARECA and CCARDESA is to promote to the continental level aspirations for transformation in agriculture and CSA, working closely with national actors. SROs are positioned to contribute towards achieving the AU/NEPAD vision by using strong partnerships at all levels. FAAP serves as a forum for promoting regional agricultural research and strengthening relations between National Agricultural Research Systems (NARS), in the sub-region, the Consultative Group for International Agricultural Research (CGIAR), and advanced agricultural research centers. The continental and sub-regional offices are important for equitable access and contribution to information generation, sharing and dissemination in order to promote CSA research and development in agriculture.

Decision making process requires Ministers for Agriculture and Food Security to ensure dialogue, synchronization of policy and programs between SROs and countries policies and targets. Engaging various stakeholders ensures that all stakeholders' opinions are taken care and well communicated. The process of engaging stakeholders is done carefully to assure inclusiveness (small, medium and large farmers and various categories of actors – NARs, Universities, financial institutions) and effectiveness of their agricultural R&D programmers (Simalenga, 2013). While linkages with various international development partners assure joint support to promote CSA, linking with FARA assures effective agriculture transformation in across Africa (Akinbamijo, 2014).

5.2 National Policies

National Adaptation Programmes of Action (NAPAs) were intended for Least Developed Countries (LDCs) to identify activities that respond to their urgent and immediate needs to adapt to climate change. The CSA factors considered in the analysis are: cross sectoral cooperation; stakeholder involvement; proportion of adaptation projects in agriculture; adaptation projects with elements of mitigation; adaptation projects related to food security and gender (Kissinger et al., 2013). The Government of Rwanda (GoR) has undertaken a number of measures to address climate change, beginning with ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, developing a National Adaptation Action Plan (NAPA) in 2000, and did put forward climate change and low Carbon growth strategies in 2010 (REMA, 2011). Tanzania signed the Convention on 12 June, 1992 and ratified it on 17 April, 1996. The Convention entered into force on 16 July, 1996 (http://unfccc.int/resource/ccsites/tanzania/), and developed a plan for action during 2007. Zambia signed the Convention on 11 June 1992 and ratified it on 28 May 1993.The Convention entered into force on 21 March 1994 (http://unfccc.int/resource/ccsites/zambia/).

So far, the NAPAs haves been among the most useful documents as inputs for Climate Smart Agriculture, adaptation and mitigation issues. They have been useful in terms of documentation of rainfall patterns, temperatures changes, vulnerability to climate change and sectoral analysis (i.e., agriculture, livestock, forestry, water, coastal and marine, and energy), Agro Ecological Zones and associated features such as crop production, soil status and climatic hazards as well as proposed adaptation and mitigation measures. The NAPAs are one of the most powerful tools that some governments use to pursue national climate-resilient long-term visions. Adaptation plans however, differ in their depth of coverage from country to country. The comprehensiveness of the NAPA for Tanzania is suggested to be due to its location in the Office of the Vice President.

The NAPAs for both countries have engaged countries development goals alongside other sector policies including the Agricultural Sector. In Rwanda, sustainable development objectives are stipulated in the documents of policies dealing with development, poverty and vulnerability such as vision 2020, decentralization policy, strategies for poverty reduction (Poverty Reduction Strategy Paper I and Economic Development and Poverty Reduction Strategy - DPRS), sectoral strategies and policies, policies and plans for the implementation of MEA (Multilateral Environment Agreement) action plans (NAPA, 2006). As for Tanzania the drawing of NAPA engaged relevant strategies and action plans relevant to the NAPA development such as the Rural Development Strategy (RDS), the Agriculture Sector Development Strategy (ASDS), and Local Government Reform (LGR), the National Strategy for Growth and Reduction of Poverty- NSGRP (MKUKUTA in Kiswahili), which is a second national organizing framework for putting the focus on poverty reduction high on the country's development agenda and the Tanzania Mini-Tiger Plan 2020 that emphasize the growth momentum to fast-track the targets of Vision 2025.

As it has been stipulated clearly in the NAPA for Zambia, the role of NAPA is therefore to augment the strategies already put in place in order to contribute to the national objectives of poverty reduction through sustained economic growth, employment creation, and enhancement of food security". This objective is well articulated in PSRP, other supportive policies, the Fifth National Development Plan (FNDP). As the NAPA in all three countries has their focus to broader goals such as poverty reduction, they are capable to be inclusive and address the national agendas towards prosperity of respective nations. The NAPAs being consultative to countries Land, Agriculture and Livestock Sector policies assures Climate Smart Agriculture to be considered as the way forward.

Over all, the process of preparing the NAPAs have been consultative, drawing from wider policies and involving various sectors ensuring the inclusiveness and sustainability of the proposed programs/projects.

In all the countries presented, NAPAs are linked with other national development policies, goals, objectives, plans, strategies and programmes and support/complement of multilateral environmental agreements related to CSA that the countries have ratified. The strongest of the international conventions that support CSA include;

i. United Nations Framework Convention on Climate Change (UNFCCC),
ii. The United Nations Convention to Combat Desertification (UNCCD),
iii. The Convention on Biological Diversity (CBD),
iv. Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal, and;
v. Vienna Convention on the Protection of Ozone Layer and Montréal Protocol on Substances that Deplete the Ozone layer.

Rwanda's NAPA as related to Climate Smart Agriculture

The NAPA for Rwanda, points out conservation and protection of lands and infrastructures against erosion, landslides and frequent floods due to climate change affecting Northern and Western districts of the country and their infrastructures comes to reinforce and support provincial efforts to act locally. Similarly, it requires mastering hydro meteorological information and early warning systems for control of climate change hazards. The installation and rehabilitation of hydrological and meteorological stations has been outlined important for planning purposes. In relation to frequent droughts, which affect marginalised populations, the realization of irrigation has potential to the improve adaptation capacity of agro-pastoralists to climate change through the setup of non-pluvial practices. Rwanda finds it important to reinforce district capacities to implement conservation measures and water storage to satisfy irrigation and animal husbandry needs.

Tanzania's NAPA as related to Climate Smart Agriculture

The existing adaptation methods in use are small scale irrigation; R&D on drought tolerant seed varieties, agriculture extension activities; diversification of agriculture; growing different types of crops on different land units, water harvesting. The potential adaptation methods include: looking for alternative farming systems, promoting indigenous knowledge, changing planting dates in some agro ecological zones, increasing irrigation to boost maize production in selected areas. Other methods include; drip irrigation for specific regions, reducing reliance on maize as staple food by growing short-season and drought tolerant crops such as sorghum and millet, shifting crop farming to more appropriate agro ecological zones, changing crop rotation practices, integrating crop and pest management. In addition, making better use of climate and weather data, weather forecasts, and other management tools, creating awareness on the negative effects of climate change, sustainable water management to boost food crop production and strengthening early warning system, following standard agronomic practices and promotion of annual and short maturing crops are all valid adaptation methods.

For livestock production, the existing adaptation methods are to strengthen cross breeding for resistant breeds, strengthen tick and tsetse control programmes, strengthen livestock extension services, improve livestock marketing infrastructure,enhance research and development and the promotion of zero grazing. The potential adaptation methods are changing land use patterns, tsetse fly control, integrated pest and disease control, sustainable range management, infrastructure development, targeted research and development, education of farmers/livestock keepers, advocating zero grazing and controlling movement of livestock.

Zambia's NAPA as related to Climate Smart Agriculture

Adaptation of land use practices (crops, fish, and livestock) in the light of climate change, aims at the promotion of; water management, crop and livestock production, growing of crop varieties and fruit trees, rearing of animal breeds that are drought tolerant, using agro-forestry practices, fish farming and processing, market access and cross cutting issues such HIV/AIDS, gender and the environment. Integrating climate-induced risk management of water resources within the agricultural sector is a key to contribute towards improving adaptive capacities of key stakeholders (policy makers, and local communities) to overcome key water availability challenges under worsening climatic conditions. Strengthening of early warning systems to improve services to preparedness and adaptation to climate change is emphasized to improve planning for Climate Smartness (CS). Zambia has outlined the promotion of alternative livelihoods in order to build community resilience to climate through the growth of diverse sources of alternative cash income.

The analysis for NAPA for Rwanda Tanzania and Zambia shows that 89.5%, 76.9% and 47.8% of the programs are directly linked to promortion of CSA. Rwanda, Tanzania and Zambia have 6, 6 and 10 options respectively in their NAPA document (See Table 5.1). The review of the NAPAs priorities for agriculture shows that agricultural sector has the same high priority. Table 5.1 shows that. Rwanda has been the country which has relatively more options related to agriculture and livestock development. It also had more budget (in proportion) allocated to agriculture and livestock issues and followed by Tanzania and Zambia respectively.

Table 5 1 NAPA engagements to Climate Smart Agriculture

	Rwanda	Tanzania	Zambia
Options in NAPA	6	6	10
Options directly involving Agriculture and livestock sector	5	4	4
Percent of budget proportion in options directly involving Agriculture and livestock sector	89.50%	76.90%	47.80%
Total budget estimates for NAPAs (USD)	7,160,000	17,170,000	14,650,000

Poverty Reduction Strategy Papers (PRSPs)

For CSA to thrive, there must be enabling policies and strategies beyond the agricultural sector e.g., on safety nets, energy, education, health, trade orientation, national budgets as should be reflected in the Poverty Strategy Reduction Papers. In Rwanda the NAPA integrated opportunities of measures and strategies of adaptation to climate change in the Economic Development and Poverty Reduction Strategy (EDPRS) is under preparation. This will complete actions and correct loopholes discovered during the preparation and implementation of Poverty Reduction Strategy Paper (PRSP I). In Tanzania, the NAPA engaged the National Strategy for Growth and Reduction of Poverty- NSGRP (*Mkukuta* in Kiswahili), which is another national organizing framework for putting the focus on poverty reduction high on the country's development agenda. Similarly, in Zambia, the role of NAPA has been to augment the strategies already put in place in order to contribute to the national objectives of poverty reduction through sustained economic growth, employment

creation, and enhancement of food security". This objective is well articulated in PSRP, other supportive policies, the Fifth National Development Plan (FNDP), and other the MEAs. In all three countries surveyed, the PRSPs have been important policy documents used to prepare National budgets, NAPAs and various programs such as the NAFSIPs.

5.3 Summary

What is emerging is that most of the countries in Africa have either a climate change policy or a National Climate Change Strategy and action Plan or NAPA/NAP/NASPA, NEMA etc. All countries have identified agriculture as important for both adaptation and mitigation as an important entry point for negotiation for CSA. The only surprising fact is that the climate instruments have not recognized that agriculture, through CSA could contribute in influencing future climate by building a reciprocating synergy. To this end, there is need to build synergy between the NAIPs/NAFSIPs and the National Climate Change instruments in those aspects dealing with agriculture in order to realize the dream of adopting CSA by the African farmers. Rwanda, Tanzania and Zambia require having specific Climate Smart Agriculture policies which will engage all the synergies together for the prosperity of the populations engaged.

6. Existing Gaps and Investment Opportunities

6.1 The CAADP CSA Framework

The AU-NEPAD Agriculture Climate Change Framework (AU-NEPAD, 2010), was designed as an agriculture/ climate change strategic tool for building capacity and addressing aspects of alignment and harmonization and financing amongst partners as well as to help African countries define and determine their agendas on agriculture/climate change as well as build informed leadership and responsibilities.

The Framework provides guidance to national and regional initiatives on programmatic approaches on knowledge generation, management, technology transfer and financing up scaling, based on adaptation and mitigation measures, including sustainable land and agricultural water management. Specifically, the Framework deals with the need for food production and commercialization; adaptation-mitigation integration; beneficial adaptation/mitigation measures; enhancing scientific capacity to improve adaptation-mitigation response, beneficial institutional policy actions and opportunities and challenges of up scaling.

CAADP pioneer agricultural development in Africa through two levels; The first level, involving agriculture as an engine of economic growth and inclusive development, whereas the CAADP framework provided guidelines to promote wealth creation; economic opportunities and prosperity – jobs & poverty alleviation; better nutrition; environmental resilience and sustainability and improved food security and productive safety nets. The second level engages agricultural transformation and sustained agriculture growth. This level has four result areas identified: increased agricultural production and productivity, better functioning national agriculture and food markets & increased intra/inter-regional trade; expanded local agro-industry and value addition; and improved management and governance of natural resources for sustainable agricultural production

The CAADP CSA framework therefore has highest emphasis on increased productivity, followed by; improved livelihoods and food security; creating economic opportunities, protecting environment and natural resources, biodiversity and mitigation to climate change. The Framework has considered the sub-components for CSA which are productivity, adaptation and mitigation; but in an illustrated manner to allow governments to translate them alongside their other policies.

As reported before, Rwanda, Tanzania and Zambia faces significant challenges from climate variability and change and that agricultural production is closely tied to management of natural resources such as water and soil. NEPAD's Comprehensive Africa Agriculture Development Program (CAADP) is the key arena for ensuring that climate change is mainstreamed into agricultural development. CAADP aims at assisting African nations raise agricultural productivity by at least 6% per year. This can be made possible through in increase in public investment in agriculture to 10% of national budgets. Such budgetary allocations have the potential to provide an opportunity for incorporating Climate-Smart Agriculture into country and regional programmes through the development of the NAIPs or NAFSIPs. These plans are the key instruments for rolling out the CAADP process (Loada, 2014).

The current survey went on to analyse and review if governments budgeted funding in agriculture sector follow the CAADP targets. In Tanzania and Zambia, the arithmetic figures for budget have been increasing progressively (see Table 6.1). There has been progress in Zambia reaching to 7.2 % of its budget allocated to agriculture in 2014 as compared to 6 % in 2011. Rwanda had its proportion in agriculture sector budget falling from 6.84 % in 2009/10 financial year to 4.4 % in 2014/15 financial year. In the same line, Tanzania had its proportion of budget in agriculture sector falling from 7.6 % in 2009/2010 financial year to 5.5 % in the year 2014/15. Enabling successful CSA up-scaling and out-scaling requires African countries to stick to their promises in the signed CAADP compacts.

Table 6.1: National Budget allocations to Agriculture sector

RWANDA (EAFF 2014; Memorie 2010,)						
Year	09/10	10/11	11/12	12/13	13/14	14/15
Agriculture budget	98 (USD mln)	97 (USD mln)	105 (USD mln)	78.377 (RWF bn)	83.979 (RWF bn)	72.132 (RWF bn)
% of Total budget	6.8 %	6.7 %	6.7 %	5.0 %	5.0 %	4.40 %
TANZANIA (NEPAD 2014; URT 2014)						
Year	09/10	10/11	11/12	12/13	13/14	14/15
Agriculture budget (Bn TAS)	722	904	926.0	1104	908	1,084.7
% of Total budget	7.60 %	7.8 %	6.9 %	7.4 %	5.0 %	5.5 %
ZAMBIA (Kuteya 2015)						
Year		2011	2012	2013	2014	
Agriculture budget (KR million)		1,231.6	1,698.0	1,865.4	3,080.0	
% of Total budget		6.0 %	6.1 %	5.8 %	7.2 %	

The small budget alocation to agriculture sector has a negative effect on agriculture research development and extension services, components necessary for CSA upscaling and outscaling. The relatively higher position in allocating budget in agriculture sector has seen a rise of 40 %, from allocation of K61.9 million in 2013 to K86.6 million in 2014 (Kuteya, 2015). The actual budget for agriculture extension to Rwanda and Zambia has been 0.5 % and 5 % of the total budget for Ministry of

Agriculture. The number of farmers reached by extension services has been, 15 %,23 % and10 – 16 % for Rwanda, Zambia and Tanzania respectively (ACTION AID, 2013)

6.2 The NAFSIPs

Various challenges have been retarding the growth of Climate Smart Agriculture as anticipated by CAADP and the NAFSIPs. Among them are production and commercialization challenges; integrating production and mitigation; scientific capacity to improve adaptation-mitigation responses. The current survey reviewed the goals for ASIP for Rwanda, TAFSIP for Tanzania and NAIP for Zambia. In the same line the survey analyzed the financing gap of the respective investment programmes.

In March 2007 Rwanda became the first country to sign a comprehensive Africa Agriculture Development Programme (CAADP) Compact (Memoire, 2010). Subsequently, the Second Strategic Plan for the Transformation of Agriculture (PSTA - II) was prepared over the period 2007 – 2008 in close consultation with the ASWG. It covers the period of 2009 - 2012 and ends at the same time as the Economic Development and Poverty Reduction Strategy (EDPRS). PSTA - II was approved by the Cabinet in October 2008. The ASIP was prepared in October 2009; it lays out the investment requirements of MINAGRI's medium - term strategic plan as formulated in PSTA - II.Both ASIP were subjected to and endorsed by an AUC/NEPAD review in the weeks prior to the December 2009 meeting. The PSTA-II (and therefore ASIP) included four programs with a total budget requirement estimated at USUSD848 million (Table 6.2).

Table 6.2: Budget share of Programmes in PSTA/ASIP (Rwanda)

Program	Proportion
Intensification and development of sustainable production systems	78%
Support to the professionalization of producers	5%
Promotion of commodity chains and agribusiness development	15%
Institutional development	2%
Total	100%

For Tanzania, the Tanzania Agriculture and Food Security Investment Plan (TAFSIP) is not a new agricultural development strategy or programme, but a sector-wideplan for coordinating and harmonising the resources needed to accelerate implementation of existing initiatives and to launch new initiatives which address national, regional and sectoral development priorities. TAFSIP has its financing mechanism and framework for the implementation of ASDP and ASP for the Mainland and Zanzibar respectively, and for emerging sectoral development initiatives on the Mainland which will be incorporated in the ASDP. In so doing, the Plan is anchored to, and aligned with Tanzania's social and economic development aspirations as expressed in Vision 2025 (for the Mainland) and Vision 2020 (for Zanzibar) together with a number of key policy and strategic statements included.

In order to achieve the above objectives, the investment plan (TAFSIP) is expressed in terms of seven thematic program areas each with its own strategic objective and major investment programmes. The main themes/investment areas are; irrigation development, sustainable water resources and land use management; production and rural commercialisation; rural infrastructure, market access and trade; Private Sector Development (PSD); Food and Nutrition Security (FNS); disaster management, climate change adaptation and mitigation as well as policy reform and institutional support. It is estimated that the achievement of 6 per cent annual growth of sectoral GDP will require investments of around TShs. 8.7 trillion (USD 5.3 billion) over the first five years to be financed by the government, development partners, private sector and other players. Table 6.3 presents the budget share of programmes in TAFSIP.

Table 6 3 Budget share of Programmes in TAFSIP (Tanzania)

Component	Percent share (%)
Production and Commercialization	71
Irrigation Development	14
Policy and Institutional Reforms and Support	8
Rural Infrastructure, Market Access & Trade	4
Food and Nutrition Security	2
Private Sector Development	0.18

In Zambia the NAIP have set five impact indicators will be tracked over a five year period through 2018. These indicators are (i) reduction of rural poverty from 77% to 50%; (ii) increase in agricultural exports as a percentage of non-traditional exports from 41% in 2011 to 55%; (iii) reduction in chronic malnutrition of children under five from 45% to 30%; (iv) reduction in soil erosion per hectare from 20 tonnes to 10 tonnes, and; (v) increase in cereals production from the 3.2 million tonnes to 6.0 million tonnes. The proportion for budget for Zambia's NAIP is as presented in Table 6.4.

Table 6 4 Budget share of programmes in NAIP, (Zambia)

Item	Budget share (%)
Crops Production and Productivity	31.2
Food and Nutrition Security and Disaster Management	24.2
Livestock Production and Productivity	13.0
Sustainable Natural Resources Management	10.3
Market Access and Services Development	9.4
Knowledge Support Services	9.3
Aquaculture Production and Productivity	1.9
Institutional Strengthening	0.7

All the Investment plans in the three countries have their priorities with similar goals to those of CSA that is promoting productivity; adaptation and mitigation to climate change. Across the NAFSIPs in both countries there is a room to include the elements of improving production and commercialization realizing the growing populations, integration of adaptation and mitigation, practicing CSA at the plot, farm and landscapes, promoting scientific capacity to improve adaptation – mitigation responses, strengthening policies and institutions, and mobilizing finances.

Although all NAFSIPs have elements of CSA there are no specific policy instruments focusing on CSA *per se* in all NAFSIPs even though the climate smart agriculture paradigm was in operation before the development of the NAFSIPs (FAO, 2010). In addition they are focused on immediate visible impacts and do not prepare for the projected medium term impacts. Loada, (2014) observed that institutions responsible for agricultural policy suffer from capacity gaps caused by lack of relevant. This results of data and data production capacities resulting in documents that are superficial or incomplete with errors of design, and allocation. The lack of skills in forecasting, strategic analysis, and ex-ante evaluation related to net benefits of investment options, legislative and regulatory frameworks and tools can lead to funding issues that are usually not well known as well as inconsistency between various regulatory authorities.

Funding the NAFSIPs

Externally funded expenditure as a percentage of total agricultural expenditure has been significant. With the revised PSTA - II and requirements of US$796 million, the revised Government of Rwanda and DP requires funding availability of US$471 million, the recalculated Government and DP funding gap amounts to (796 – 471) = US$325 million. However, the funding gap reported in ASIP included a US$55 million private sector funding gap, while the recalculated funding gap excludes the private sector funding gap. This funding gap of US$325 million was needed to be financed exclusively by external partners, as the Government contribution has already been taken into account and private sector as well as beneficiaries activities have been removed from the total that needs to be financed (Memoire, 2010).

The financial analysis gap on the Tanzania mainland shows that the percentage of gap in total requirement to increase from 16.89 % in 2010/11 to 32.73 % in 2013/14, in total the gap of funding sums to 50 % of the total requirements. In Zanzibar, the financial gap in agriculture has been progressively shrinking with time. While the existing financial gap in agriculture was 87.8 % in the year 2009/10 it has been 21.1 % in 2014/15. In Zanzibar, the gap is USD 75.3 million, an average of 9.4 million per year. On average, the gap is about 49 % of the total sector requirement per year (NEPAD, 2014b).

In Zambia, global financial resources that are aimed at catalyzing low-carbon and climate-resilient development, represents a source of funds that could potentially be used to reward the positive externalities of NAIP. The costs associated to specific CSA activities have been identified and are included in the total requirements. The estimated financing gap is approximately equivalent to USD605.23 million which represents approximately 22 percent of the total requirements for the NAIP (NEPAD, 2013).

The current survey has clearly shown that funding the NAFSIPs has been a challenge to up scaling and out scaling of CSA in the countries in Eastern and Southern Africa. Rwanda, Tanzania and Zambia have prepared NAFSIPs to integrate the scaling up of practices that augment development, food security, and climate change adaptation and mitigation. Both adaptation and mitigation actions required for future agriculture are projected to lead to significant increases in need for financing, and gaps are expected to widen if innovative methods of financing are not found. Support to adaptation projects has been through separate funding mechanisms from mitigation projects even though some adaptation projects have mitigation aspects. Supporting the funding of the NAFSIPs is a potential venture / opportunity to invest in CSA.

Most CAADP Country Investment Plans (CIPs) have identified land and water management as priorities and endowed them with significant budgets. However, many CIPs failed to explicitly address climate change and, when present, climate change is not adequately integrated. Statistics below shows the priority areas where GAFSP funding has been applied (Table 6.5).

Table 6 5 Role of NAIPs in accessing and application of GAFSP funds

Country	Year of accessing GAFSP funding	Amount obtained (US USD)	Priority areas
Rwanda	2010	50m	Implement hillside irrigation.
Tanzania	2012	30m	Rehabilitation of irrigation schemes and value chain development for rice
Zambia	2013	31.1m	Improve food production; develop value chains and capacity building.

Source: http://www.gafspfund.org/

The growing realization of the negative repercussions of climate variability and change on rural livelihoods has led to increased focus on climate and agriculture in Africa. The United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) and negotiations between governments are ideal for countries and RECs to strengthen the climate and natural resources management components of their CAADP programmes in a systematic manner.

6.3 Supporting incentive systems for implementing CSA (fertilizer use)

Challenges such as soil erosion and heavy rains have resulted in the need for farmers to implement soil conservation measures and continually replenish lost soil nutrients; hence agriculture intensification in Rwanda. However, the level of fertilizer used per cultivated hectare in Rwanda is extremely low, estimated at 4.0-10 kg/ha annually. The level of fertilizer used per cultivated hectare in Tanzania is about 6.0 kg/ha. In Zambia, the level of fertilizer used per cultivated hectare in Zambia is about 50 kg/ha (a recent increase from about 11 kg/ha before the subsidies) (IFDC, 2013). Rwanda, Tanzania and Zambia governments are still obliged to see that farmers are given adequate support to afford fertilizer use. Subsidies could be channeled as institutional support, pre-financing or polices that recognize and reward CSA practices or facilitate trade of CSA technologies. Table 6.6 narrates performance of fertilizer subsidy programs for Rwanda, Tanzania and Zambia respectively.

The analysis during the study of performance of the eight countries fertilizer programs grouped Rwanda and Tanzania as countries with more market friendly subsidy programs as compared to Zambia which has the less market friendly subsidy program (see Table 6.6). Both countries are obliged to see that more farmers are accessing fertilizer and in appropriate time. Fertilizer availability, accessibility and appropriateness in the utilization of fertilizer are one of factors to promote Climate Smart Agriculture in Africa. As given in Table 6.6 and Table 6.7, there is room to intervene to assure that adequate fertilizer is available and delivered in time.

Table 6.6: National performance of fertilizer subsidy programmes

Variable	Country		
	Rwanda	Tanzania	Zambia
Accessibility	(-) distance to reach farmers is long	(+) distance to reach farmers declines from 40kms up to 5 kms	(-) late delivery
Subsidy rate	(+) reduced price by 72 % in	(+) reduced price by 50 % in 2009/10	(+) reduced price to 50 % in 2009/10
Voucher availability	(-)electronic system not well in place delaying fertilizer availability - smallholders	(+) well set criteria to identify beneficiaries - poor;	(+; -?) not targeted at the poor, but rather at those farmers with productive capacity to use the subsidies best. As such, any farmer can buy the subsidized fertilizers.
Complementary services	(+) linked to improved seeds and MFIs	(+) Agro dealers received training and finances	(+) Improved seed, extension services and accessibility to finance
Fertilizer availability	(+) actual amount as percentage of intended fertilizer 99.6 % in 2009	(+)actual amount as percentage of intended fertilizer 76 % in 2009/10	(+) subsidized fertilizer supplied by the Government of Zambia increased by more than 50 % FISP now covers about 50 % t of small-scale farmers countrywide
Impact on private sector	(-) no expertise on fertilizer distribution; just importation	(+)training to agro dealers; Value chain strengthened	(-) private sector import 100 % government supplies (50 %). Private sector relaxes on distribution

6.4 Improving market and financial access

Market and access to finance can be done through improving marketing and information infrastructure. The widespread availability and accessibility of modern information technology such as internet services, social media, mobile phones and radios in urban and rural areas is a major opportunity. The status of marketing and financial infrastructure is not conducive in Rwanda, Tanzania and Zambia. Poor markets infrastructure and inaccessibility of financial service call for more interventions in the respective areas, hence investments opportunities.

6.5 Mainstreaming Gender in CSA

In Rwanda, Women contribute up to 70 per cent of agricultural labour and do 80 per cent of the sowing, 65 per cent of food processing, 61 per cent of hoeing and 72 per cent of the storage and transportation of produce (AFDB, 2008). In Tanzania, the agriculture sector employs nearly 80% of the workforce in Tanzania out of whom 90 % are women. http://www.ilo.org/public/english/region/afpro/daressalaam/activities/economic.htm. Zambia women constitute around 65 per cent of smallholder farmers (IFAD, 2011). Women in Zambia are the main producers of food and manage, either independently or jointly, around 60 per cent of the land under maize production. It is clear that women must be central to any initiative.

Women's rights to property vary within and between countries in sub Saharan Africa. A gender-sensitive approach is crucial to achieving CSA. The roles, responsibilities and capabilities of men and women need to be well understood to ensure that both men and women have access to and benefit from CSA practices and policies. Some of the gender constraints that need to be addressed include the fact that land tenure systems and availability of funds to invest in better technologies are gender-sensitive. Because of this, women and men both show differences in responding to climate change and in taking up opportunities presented by CSA. Through understanding of how climate change will impact men and women differently, programmes and policies promoting adaptation to climate variability and change can be designed to ensure that impacts are addressed in gender-equitable ways in order to increase adoption of CSA.

Table 6 7 Summary of performance analysis of fertiliser subsidy programmes

<table>
<tr><th>Country (year subsidy introduced)</th><th>Role of Government</th><th>Role of Private Sector</th><th>Input Voucher (Yes/no)</th><th>Other Attributes</th><th>Scores</th></tr>
<tr><td>Tanzania (2008)</td><td>Pay importers based on coupons
Distributes coupons</td><td>Importation
Wholesaling
Transport
Warehousing
Retailing</td><td rowspan="2">Yes</td><td rowspan="2">✓ Improved seed subsidy
✓ Extension service
✓ Credit support
✓ Quantity limit
✓ Pre-season registration</td><td>14</td></tr>
<tr><td>Rwanda (2007)</td><td>Importation
Wholesaling</td><td>Transporting
Warehousing
Retailing</td><td>12</td></tr>
<tr><td>Zambia (2003)</td><td>Purchase from importers
Warehousing</td><td>Retailing
Importation
Transport</td><td>No</td><td>✓ Improved seed subsidy
✓ Extension service
✓ Credit support
✓ Quantity limit
✓ Pre-season registration</td><td>10</td></tr>
</table>

Although women do suffer most the consequences of climate change, their traditional responsibilities fail to allow them attend technology transfer sessions. In Chololo Eco village, Tanzania participation of women in training programmes was determined by cultural norms and roles and the topic of training (Kalumanga, et al., 2014). Women tend to be left out of events involving agricultural technology transfer because they stay at home to attend to children, and elderly and ill relatives (Kalumanga, et al., 2014). Level of participation goes up when trainings involve income generating activities (Kalumanga, et al., 2014). Climate change programs should make sure that they are striving to become gender inclusive. Countries should reorient agriculture spending to focus women farmers, providing extension services, technology and crops involved, agriculture research programmes, credit schemes, input subsidy programmes to ensure that women are treated equally under the law and in practice especially on land ownership (ACTION AID, 2013). Gender disaggregated data are always necessary to be in place to assure appropriate support to women towards the up scaling and out scaling of CSA in Africa. Channeling CSA investment through the support to women will make CSA up scaling and out scaling successful.

6.6 Climate Smart Agriculture Alliance as an investment opportunity

The NEPAD through the CAADP has launched an alliance of diverse partners, the International Non-Government Organizations – INGOs (CARE, Catholic Relief Services, Concern Worldwide, Oxfam and World Vision) and technical partners such as CGIAR, FANPRAN, FAO and FARA with the aim of reaching 25 million farming families through Climate-Smart Agriculture and become more resilient and food secure by 2025. Considering various geo physical features and existing farming systems, the Alliance has been developing a road map to stimulate the uptake of CSA practices focusing on the vulnerable rural communities (http://africacsa.org/). The current study is a contribution to establish a road map for up scaling and out scaling of CSA in Africa.

A major concern in this effort is how to coordinate and facilitate the scaling up of on-farm assistance, linkage to technological advances and support to a favorable policy environment for implementation of CSA and bringing a lasting transformation of farmers. Members will work collaboratively to design and implement programmes in a way which maximizes the efficiency, effectiveness and impact of investments. The Alliance expects to leverage existing CSA initiatives and the strengths and capacities of each Alliance member to deliver results at scale and drive policy reform. This will be achieved through aligning INGOs and research activities across Africa with the existing national agricultural investment plans, increasing coherence and coordination towards adoption of CSA strategies by the targeted number of farmers.

Currently, the CSA Alliance has been working towards improving Hillside Productivity in Rwanda Rwanda's Land Husbandry, Water Harvesting and Hillside Irrigation Project which seeks to better manage rainfall so that it causes less hillside erosion, through terracing, improving the soil under cultivation, managing water runoff and in some cases developing irrigation systems. The CSA Alliance is also seeking to empower farmers by helping them develop farmer groups (rare in Rwanda) and gain access to credit (World Bank, 2014). In Rwanda, local farmers were employed to build terraces, and reported an increase in yields and income. More than 65 percent of the first potato harvest was sold in the market (after satisfying people's own food needs) whereas only 10 percent used to be sold in the past.

Along the same lines, conservation farming is a package of agronomic practices that have been promoted in Zambia by a coalition of stakeholders from government, donors and the private sector, since the mid- 1990s. The system is comprised of dry-season land preparation using minimum tillage methods, utilizing fixed planting stations (small shallow basins); retention of crop residue from the prior harvest in the field or use of other mulches/ ground covers; and rotation of crops in the field (World Bank, 2010). In Zambia, the scaling up program has recently added a tree component — the planting of *Faidherbiaalbida* — has been potential to doubled maize yield and increased by 60 percent for cotton using conservation farming, compared to conventional plowing systems. The program has thus been able to achieve the triple win of enhanced productivity, resilience and carbon sequestration.

The CSA Alliance is a potential partner to promote the out scaling and up scaling of CSA in Africa. The practices in Rwanda and Zambia have shown its potential to the up scaling and out scaling of CSA in Africa. The alliance is still open for various initiatives and calling for new partners. Financiers, development agencies, scientific, technical organizations and the private sector are important to an alliance since the alliance continuously requires technical assistance and access to markets (http://africacsa.org/).

6.7 Summary

There are many CSA opportunities worthy of attention. At the governmental, regional and continental level, food security is a major concern in the national poverty reduction strategy papers, agricultural development and investment plans of West African countries and the agendas of international organizations. There is increasing awareness of the impacts of climate change on agriculture and the need to respond in appropriate ways by governments, regional and continental bodies facilitated by FARA and its SROs such as ASARECA and CCARDESA, also through exchange of experiences on CSA between NARIs and CGIAR centers. Frameworks for implementing NAFSIPs and PRSP are well set up and in line with government policies of decentralization of certain functions to district levels could all be exploited for CSA.

The surveyed countries have been struggling to finance agriculture. It is well known that adequate and sustained financing is fundamental for CSA to be widely adopted by small scale farmers. The CAADP framework provides guidance on sustainable financing and is therefore an opportunity worth exploiting. CAADP (2010) outlines these as follows: developing, adapting and providing to country and regional initiatives instruments and capacity development support to engage and negotiate at global level for financing African Agriculture from sources covering broader climate change objectives. The CAADP framework also suggests; targeting and facilitating direct engagement and access to;

(i) bilateral and multilateral development aid,
(ii) direct foreign investments and local private financing and
(iii) special instruments for public-private co-financing arrangements; providing instruments and related local capacity development in management, budgeting, disbursement, accounting and auditing.

The newly established Green Climate Fund (GCF) may shift the balance between mitigation and adaptation funding. In addition the Global Environment Facility (GEF)'s move towards combining mitigation and adaptation in the GEF-6CCM (FAO, 2013) is another source of Funds for CSA.

There are national farmers associations and regional farmer's association (ROPPA) playing advocacy roles for farmers. At the community level, there is social capital in the form of Community and Farmer Based Organizations. The social capital in rural communities which brings rural folk together to alleviate labor shortage at critical periods in the farming calendar and in reacting to natural disasters are also opportunities for CSA. Many farmers (producers) are now aware of their vulnerability to the effects of climate change and are already adapting. Investing in areas that could influence adoption of CSA across Africa.

7. Key Drivers For CSA Adoption

7.1 Drivers for Promoting CSA

Diffusion of CSA innovations is a socio-cultural process that can be promoted with support from policies and institutions aimed at developing sustainable change in a community. Spontaneous spread of innovations occurs almost exclusively through farmer-to-farmer information exchange (Liniger and Critchley, 2007) yet adoption of CSA in Africa is still very low. Africa is yet to have a unified definition of climate change or at least obtain a unified understanding of the effects of climate change. Just like in other parts of the world, climate change has been misunderstood to mean a variety of problems affecting farmers. Awareness about climate change in developing countries is still low compared to the developed world, with African countries rated as the least aware (Pelham, 2009). In some cases, African farmers have been found to have a problem in differentiating between impacts arising from climate change and problems caused by local environmental degradation (Mutimba, et al., 2010).

The current study divided the analysis into two parts. The first part entailed the farmers themselves and their capacity to adapt Climate Smart Agriculture and hence increase productivity; adaptation and mitigation to climate change. The second part examines the national systems, and went through the analysis the nation's capacity. That is, national capacity to support their people towards up scaling and out scaling Climate Smart Agriculture. In both parts, the capability of individual farmers and governments provide options for the countries to successful adopt CSA. Farmers and national vulnerability to climate change is based to two variables, physical exposure and ability to cope with impacts.

7.2 Farmers' awareness on climate Change

Knowledge of farmer and farm characteristics facilitates the appropriate targeting of agricultural technologies to households and locations where they are most suited and therefore lead to good chances of adoption. It also helps to assess the willingness to take risks (Charness and Viceiza, 2011). If climate change is to be taken seriously, communities have to be surveyed to access if their perception of climate change is real and if it has an impact on their livelihoods. As summarised in Table 7.1, the surveys done in Rwanda Tanzania, and Zambia showed that the communities in the surveyed countries are aware that climate change is real. However, while communities in Rwanda could directly mention that there is climate change, 80 % of respondents in Zambia noticed the indicators of climate change such as unpredictable rains but without being able to link unpredictable rains to climate change. Farmers ackowledging that climate change is happening should be a first step to adopt Climate Smart Agriculture.

Table 7.1 Farmers perception on climate change across Rwanda, Tanzania and Zambia

Hazard/Climate Signal	Rwanda (Choise Africa 2013)	Tanzania (Swai et al., 2012)	Zambia (Kalinda 2011)
Existence of climate change	80	53	27
Human activities as a cause of cc	75	15	43
Drought	23	99.45	46.37
Floods	7		54.72
Soil erosion	8		
Hotter temperatures	12	97.75	41.79
Unpredictable rains	11	81.95	80.53
Domestic animal decline	5		
Stronger winds		96.4	

7.3 Farmer and countries capacity to adopt CSA

As shown in Table 7.2, poverty, food insecurity, population pressure on the land (in case of Rwanda), reliance of rainfall for agriculture production, and the majority of the people engaged in agriculture production have been concerns of countries vulnerable to climate change hence having logic to invest in CSA. Again poverty, poor accessibility to markets, finances, and extension services have been factors hindering farmer's capability to adopt climate smart agriculture in Rwanda, Tanzania and Zambia.

Similarly, analysis was done to identify each country's potential to invest in Climate Smart Agriculture. The analysis was based on (Rwanda, Tanzania and Zambia) socio economic profiles as countries. Understanding socio economic parameters and is key to understand the position / potential of involved countries to adapt and practice Climate Smart Agriculture. All the three countries are categorised as LDCs (see Table 7.2). LDCs are the ones with low per capita income, and are based on Human Assets Criteria and Economic Vulnerability Criteria.

Table 7.2 Socio-economic and demographic indicators of the surveyed countries

INDICATOR	Rwanda	Tanzania	Zambia
Income	Low	Low	Low Middle
Population 2012 (mln)	11,450	47,738	14,075
Annual ppn growth – 2012	2.8	3.1	3.2
Life expectancy 2011	62.9	60.1	55.8
Ppn density (per km2) 2011	452	52	18
Fertility rate	4.7	5.4	5.8
GNI per capital (USD)2012	560	570	1350
Total Debt stock as % of GNI	17.5	42.5	24.2
Economic Vulnerability Index (EVI)2012	47.3	28.7	53
Human Asset Index (HAI)2012	42.2	40.1	36.9
Humanity development Index (2012)	0.43	0.48	0.45
Real GDP growth rate (2013)	7.6	7.0	7.8
Gross Capital Formation - % of GDP (2011)	21.4	32.9	24.9
Gross Domestic Savings - % of GDP (2011)	2.3	22.6	34
External Resource Gap % of GDP (2011)	-19.1	-10.3	9.1
FDI inflows mln USD 2012	159.8	1706	1066
Share of value added (Agric/fish/forests, hunting) (2009 – 2011)	34.8	28.5	19.7
Land Area (000)km2	24.7	743.4	885.8
% Arable land and under permanent crop	59.6	15	4.6

(UNCTAD, Statistical Profiles of the Least Developed Countries 2013)

The observations from Table 7.2 are that Rwanda is more challenged by high population density; the EVI shows that Zambia has the high economic vulnerability followed by Rwanda whereas Tanzania is best. The HAI is a composite indicator which combines four indicators, two indicators of health and nutrition outcomes (percentage of the population undernourished, Mortality rate for children aged five years or under) and two indicators of education (gross secondary school enrolment ratio, adult literacy rate). The higher the HAI score, the better the welfare position of the country.In this case, Rwanda had relatively better welfare position followed by Tanzania and ultimately Zambia.

The Humanity Development Index was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. The HDI can also be used to question national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes. These contrasts can stimulate debate about government policy priorities. Calculation of the index combines four major indicators;

life expectancy for health, expected years of schooling, mean of years of schooling for education and Gross National Income (GNI) per capita for standard of living. High HDI connotes the better development position of the country.Though Tanzania had the highest HDI the figures are close across the three countries.

The real GDP was almost similar in three countries (around 7 %), whereas Tanzania had the highest inflows of Foreign Direct Investment (FDI), Rwanda had the highest share of proportion for agriculture produce. Rwanda already, has the relatively large part of its arable land under cultivation. This reflects the population challenge of the country and its requirement for embracing the Climate Smart practises in production.

The analysis shows outright that the countries are not in position to support the welfare of its own people but also to invest substantially in ventures such as CSA. International support is therefore required to upscale and out scale CSA in Rwanda, Tanzania and Zambia.

7.4 Providing an enabling legal and political environment

One of the core values of good governance is democracy. Democracy and its rules constitute the political and ethical guides that organize the relations between civil society and state. The rules of democracy include consensus, controlled power, accountability, legality, and access to information, among others. All these rules are aimed at generating a space of trust in the relationship of social and political actors including those in agricultural development. Continuing efforts to work close to national governments though NEPAD and SROs such ASARECA and CCARDESA are key to ensure participation of all potential stakeholders to promote CSA. Placing the countries' Ministries of Agriculture council as the top most deciding organs in the respective SROs will continue to ensure countries political will and support to the up scaling and out scaling of CSA in Africa.

Land tenure systems in Africa

In all countries in Africa men control access to land through customary tenure, and, as a result, are often considered the main decision-makers in terms of crop management, investment options and other major decisions including long term investments. Implementing CSA programmes that incorporate long terms investment requires their commitment and 'buy in'. On the other hand, women have greater authority over food production and may supply up to 80% of the labor required in the household to produce food. Women are also more likely to interact well with extension staff and other agencies that promote CSA compared to their male counterparts. Unclear land tenure may lead to difficulties in establishing benefit distribution mechanisms for payments for ecosystem services (Runsten and Tapio-Bistrom, 2011).

There is also a need to address the land tenure issue to ensure that women's rights to land and long term investments inhouseholds are recognized and enforced. Proposed changes should be adapted to a country's particular tenure systems to minimize conflicts with culture and tradition and competing uses. Although Rwandan law guarantees women's rights to land tenure, traditional practices still lead to gender discrimination. Consequently, many women are unable to own, control or inherit land. The Rwanda Initiative for Sustainable Development works to increase community awareness of land rights, especially for rural women who depend on land for their livelihood. One key area of intervention is land registration, which gives wives an opportunity to secure their property rights to land that is registered in the names of both spouses (Carpano, 2011). Despite equal-rights legislation on the books in Tanzania, customary norms continue to limit rural women's ownership and control of land. The Sustainable Rangeland Management Project – implemented by the International Land Coalition with technical support from IFAD – was set up in 2009 to help secure women's land rights through the Village Land Use Planning process. Support for gender equity is essential to the viability of this process, which requires community-level plans for the use of land and natural resources in rural areas (Carpano, 2010).In Zambia, at some places women are denied ownership to land (IFAD, 2011).

There is no country with a comprehensive land tenure system, that satisfies the needs of all stakeholders although countries such as Zambia have to a large extent, secure land tenure systems. But even in these countries, there are vast areas with the potential of embracing CSA technologies but with no secure land tenure systems. In all the countries and AEZs in Africa, even without secure land tenure systems, there is a potential for contracting farmers use of land on long term basis.

Market failures

Realizing the potential of CSA depends on the ability to convey market information, coordinate production and marketing, define and enforce property rights, and mobilize farmers to participate in markets as well as enhance the competitiveness of agro-enterprises (FAO, 2012). Implementing CSA requires a marketing system that conveys timely and accurate information on production and marketing for the products grown or to be grown. In the rural communities, there are no structures to convey such information, particularly on markets for their produce. The issue is that because of lack of the institutions to convey the information and lack of proper marketing mechanisms there is generally a market failure and the forces of demand and supply of produce do not work.

Poor Business Development Services (BDS)

BDS include financing, market information, input supply, extension, collection and process, storage and transport. Farmers in the surveyed countries can best be described as being risk averse and preferring not to use credit for their farming activities. The reason could be linked to a poor business environment that is unable to respond to the unique needs of farmers and develop a financial product suitable for them. On the other hand, the produce market is highly volatile with prices being unpredictable and farmers are in a non-structured marketing system. There is need to improve the overall agribusiness environment through simple, transparent regulations, tax structures and finance regulations in order to attract more investment in the sector.

Institutional/Socioeconomic challenges

Government ministries work more or less independently and food security is perceived as mainly the responsibility of one ministry (Ministry of Agriculture), when food security by definition, implies involvement of a range of government ministries.

There are several human, social, and economic challenges at the community level. Traditional systems of inheritance and ownership of land have consequences for the adoption of 'investment technologies', involving planting of trees, making soil and water structures expected to last for several years. For example where inheritance of land is patrilineal, decisions are made by the head of families on allocation of land for annual cropping , and women and strangers can have access to land even though women provide a very large part of the agricultural labor force. However, tenants (strangers) are excluded from planting of perennial crops or trees because planting trees indicates long term interest and investment in the land meaning that the planter owns the land. Other challenges are high level of poverty and illiteracy, poor health status in rural areas, high investment costs of CSA, and inadequate access to land, labor, and credit for agriculture especially for women. Rural to urban migration by youth contributes to labor shortage at critical periods and this impacts most seriously on the adoption of soil and water technology high at initial labor demands e.g. stone bunds and zai.

Research/Technology Transfer

Research on how to mitigate the impacts of climate change and variability to agricultural productivity is still very limited (Antai, et al., 2012). There is inadequate knowledge of how technical CSA practices will perform in specific locations; appropriateness and profitability of technologies; and little or no knowledge of how trade will be affected by climate change. Current GCMs sometimes give conflicting predictions of impacts on crop yields; inadequate knowledge of risk management in terms of insurance in some countries; limited understanding of landscape approach in achieving CSA. The numerous tiny farm holdings for crop farming do not facilitate this, as well as limited or no involvement of policy makers in the research process, and ineffective forms of communicating research results to policy makers and end users.

Finances

The initial investments in CSA are generally high while the benefits may not be immediate. Governments are constrained to provide the required funding even for their NAFSIPs, PRSPs and institutions responsible for data collection and research. The bulk of funding required for key programmes is from external sources. Incorporating CSA approaches would require additional funds.

Policy, plans and programmes

Mitigation benefits associated with adaptation options are not recognized in national agricultural development and investment plans. Apart from the NAPAs and communications to UNFCCC, climate adaptation programmes are usually separate from agricultural development policies, plans and programmes. Policy contradictions may occur because of failure to recognize and manage trade-offs when CSA is not aligned with agricultural policies. Other challenges are that livestock policies are separate from crop policies. There is lack of political will and reluctance to invest in perceived medium and long term uncertainties and the research to policy- making linkage is often linear. The importance of research, as part of overall agricultural policy is still not adequately recognized. IMF/World Bank policies discourage provision of subsidies in the agricultural sector and governments have resorted to 'food for work' and reduction of duties on imported agricultural inputs as incentives. How effective these are is uncertain.

8. Creating Enabling Environments for Adoption of CSA

8.1 Creating enabling environments to stimulate CSA

The need to build synergy between NAIPs/NAFSIPs and national climate change instruments, particularly NAPAs/NAPs and NAMAs is as a result of stimuli obtained from the activities given below.

Encouraging Farmers to Adopt Climate-Smart Practices

The priority for small-scale farmers in Africa is to mitigate the impacts of climate change and increase their production. Mitigation is often a positive non-intended outcome unless when farmers have incentives to do so. Where appropriate, policymakers should encourage such incentives to operate and farmers to reap the benefits of adopting CSA.

Understanding benefits of practicing CSA such as minimum tillage, the retention of organic matter and crop rotation, helps farmers reduce their carbon emissions, increase crop yields and cope with climatic variability. For instance, agroforestry, which involves planting trees on farmland, can sequester carbon, improve soil fertility, reduce soil erosion, provide alternate fodder and raise smallholders' incomes. Farmers are encouraged to adopt these technologies if they are educated in order to realize the reduction in climate change risks associated with the adoption of climate-smart practices.

Adopting a multi-sectoral approach to policy making

Increasing adoption of CSA practices requires action and facilitation by a wide range of actors at different levels of hierarchy in the resource and power base. Typically, a successful CSA policy should encourage resource allocation and action by a wide range of government ministries, including those with responsibility for agriculture, rural development, research, environment, trade, education and transport.

Creating the financial incentives for CSA

Successful CSA strategies will require investment in infrastructure that can support smallholder farmers in understanding climate change, developing and refining strategies and evaluating CSA options. Some researchers have recommended establishment of transition funds to be used to compensate farmers during the period between the establishment of CSA structures such as agroforestry practices and the time the positive impacts of agroforestry would be felt by the farmers. CSA provides an opportunity for farmers to benefit from additional funds through the Payment for Environmental Services (PES) schemes. But development of PES programmes is beyond farmer's capacity and a special fund could support farmers to benefit from such schemes leading to higher adoption of CSA practices.

Developing effective research

The present state of research in Africa especially in the NARIs and universities is characterized by dilapidated, overburdened facilities and often with few women on staff. There are limited systems for data sharing and few research learning platforms with CSA learning areas. The research agenda for a research institution or scientists is often informed by a wide range of factors including the supplier of the research funds. Developing a research scheme with funds locked to CSA studies will ensure that the CSA practices are continually improved and modified to changing climate and farmer circumstances. As it has been discussed earlier, securing adequate funding for research is pertinent for up scaling and out scaling of CSA in Rwanda, Tanzania and Zambia.

Main streaming CSA at the national and international Levels

CSA will gain the necessary attention if it is mainstreamed into national agendas and strategies and also into the international negotiations forums. There is need to lobby governments to consider CSA as an important intervention measure to improve well being and incomes as well as food and nutrition security.

Mainstreaming gender in CSA

Climate change programs should make sure that they strive to become gender inclusive. Countries should reorient agricultural spending to focus women farmers, providing extension services, technology and crops involved, agriculture research programmes, credit schemes, input subsidy programmes to ensure that women are treated equally under the law and in practice especially on land ownership (ACTION AID, 2013). Gender disaggregated data are always necessary to assure appropriate support to women towards the up scaling and out scaling of CSA in Africa

8.2 Priority crops and livestock suitable for CSA

In Rwanda, the principal food crops are plantains, sweet potatoes, cassava, potatoes, dry beans, and sorghum. Coffee and tea together generally contribute 80% to export earnings. Rwanda also exports quinine and pyrethrum. Rwanda also produces corn crop came and sugarcane http://www.nationsencyclopedia.com/Africa/Rwanda-AGRICULTURE.html. Following the Crop Intensification Program (CIP), a flagship program implemented by the Ministry of Agriculture and Animal Resources to attain the goal of increasing agricultural productivity under PSTA II. CIP aims to accomplish this goal by significantly increasing the production of food crops across the country. CIP currently undertakes a multi - pronged approach that includes facilitation of inputs (improved seeds and fertilizers), consolidation of land use, provision of extension services, and improvement of post harvest handling and storage mechanisms. Started in September 2007, the CIP program focuses on six priority crops namely maize, wheat, rice, Irish potato, beans and cassava.

Maize, sorghum, millet, rice, wheat, beans, cassava, potatoes, bananas and plantains are staple crops in Tanzania while coffee, cotton, cashew nuts, tobacco, sisal and pyrethrum, tea, cloves, horticultural crops, oil seeds, spices and flowers are cash / export crops in Tanzania (Makoi, 2014). Vines however are increasingly becoming important cash crops in central semi arid / arid zones of Tanzania.

In region I of Zambia, there is predominantly small-scale farming in the major valley systems. In the Luangwa Valley, sorghum, finger millet and maize are the major starchy food crops, while groundnuts, cowpeas and pumpkins are also grown. Other areas of the region mainly produce bulrush millet, sorghum, and cassava. Zambia's large commercial farmers are concentrated in Region II. Their farming systems are mechanized and highly diverse, cultivating maize, soybeans, wheat, cotton, tobacco, coffee, vegetables, and flowers, and breeding livestock. Besides these large-scale systems, there are also small- and medium-scale farmers in the region. Maize is the main staple crop in these systems in Central and Eastern provinces. Beans, groundnuts, pumpkins, and cassava leaves are grown to diversify diets. Other crops include cotton, sorghum, soybeans and sunflower. Farmers also grow tobacco in this Zone. The major constraints to increase crop production in Region II are the lack of low-cost biocides to control pests and diseases, soil degradation, and the depletion of soil fertility.

Small-scale farming predominates in Region III. Rural areas of this region have the lowest population density in Zambia. Farmers use very low-input, shifting and semi-permanent cultivation techniques. *Chitemene* and *fundakila* are two widely used, traditional methods of cultivation. Principal crops in the hand hoe system of Northern, Luapula and Northwestern provinces are cassava, landrace maize varieties, sweet potatoe, pumpkin, finger millet and beans. Most farmers have chickens and a few goats, but other livestock is uncommon. The existence of tsetse fly in some areas limits opportunities for cattle production (Chikowo, 2014).

Research and development work has so far involved a limited number of crops but this should not be interpreted to mean that they are the only "crops suitable for CSA". There are overlaps in the distribution of crops and livestock across the agro climatic zones and the distribution will change further as rainfall, temperature and length of growing period change. Millet is the major food crop in the semi-arid zone; other crops of importance are sorghum, cowpea, groundnut, cotton and vegetables. Cattle are the major livestock but small ruminants (sheep and goats) and poultry are also found. In the sub-humid zone, sorghum, rice, maize, groundnut, cowpea, sweet potato, potato, cotton, vegetables, legumes, are important. The same livestock that are found in the semi-arid zone are also raised here. The major crops in the humid zone are rice, maize, beans, vegetables, cassava, sweet potato, rice, coffee, but sorghum ,groundnut and cowpea are also grown in the drier parts. Sheep, goats, small ruminants and poultry production is widespread. Cattle are raised in the drier areas of the zone but cattle production is of much less importance compared to the semi-arid and sub-humid zones. Pigs are also raised.

Local breeds of livestock are more tolerant to heat stress and drought as compared to exotic breeds. Much more research has been done on the effects of climate change on crops than livestock. Improvement of genetic potential has been important to cope with the changing climate (water stress and increased temperature) and their consequences such as emerging pest and diseases. Improving genetic potential has been very important for farmers to realize higher yields and hence realize benefits of Climate Smart Agriculture.

9. Conclusion and Recommendations

The conclusions and recommendations presented here are aligned with the specific objectives of the study.

9.1 Successful CSA practices for scaling up and out

Climate Smart Agriculture is real and is being promoted by regional organisation such as NEPAD. Various elements of CSA are being implemented across Africa. Many of the technologies are designed first to increase production rather than protecting the natural resource base.

Recommendation

Successful CSA practices should be up scaled and out scaled to other areas with the same Agro Ecological Zones. Thorough research should be done on the matter of total productivity to be able to quantify realize profits as illustrated by NEPAD CSA framework. Governments and NGOs should invest and take a lead in such venture. The community-based participatory climate smart village approach involving climate risk management should also be promoted.

9.2 Policies that Promote Climate Smart Agriculture

There are no specific policies promoting CSA at national, sub-regional, and regional levels. The National Food Security and Investment Plans all have elements of CSA but they do not explicitly promote it. No proven successful national policy model for inter-sectoral collaboration and leveraging of finance was identified in the study although policy and strategy documents mention inter-ministerial committees and decentralization of government functions to district level.

Recommendation

Enabling policy environments for CSA to thrive should be developed by governments through;

(i) Recognition and accommodation of multiple objectives of increased food security, adaptation to climate change and reduction of GHG emissions

(ii) Creation of incentives

(iii) Alignment of CSA with good economic, health, social, infrastructural and environmental sectoral policies and programmes so that they are mutually supportive

(iv) Support for data collection and analysis to identify which strategies will best lead to sustainable food security, adaptation, and mitigation benefits

(v) Mainstreaming of CSA into NAFSIPs and overall agricultural strategies

(vi) Improved land tenure security, taking special considerations of the needs of vulnerable groups like women and youth, and

(vii) Improved access to information and knowledge from institutions that generate knowledge; promote climate risk management (insurance, weather forecasting, social safety nets) to cope with risks associated with climate change and adopting new practices. CSA should be mainstreamed into national policies and programmes.

Generally, there is need to step up dialogue with national governments to streamline CSA in government programmes, policies and institutions. FARA will be relied upon to drive this agenda and achieve coordinated efforts towards CSA.

9.3 Existing gaps and investment opportunities

There are significant gaps in capacity, technical knowledge and financing of Agriculture Sector budget (ASB) and the NAFSIPs. Countries are failing to comply with setting 10 % of their budgets to agriculture sector. Studies on the impacts of climate change on livestock are inadequate. There is also few models deal with livestock and none deal effectively with heat or water stress effects. In addition, integration of adaptation and mitigation into policy and practice, or mainstreaming of climate change issues into agricultural development are limited.

Recommendation

It is recommended that practitioners of CSA (researchers, development workers and organizations) should: consider gaps dealing with crop and livestock research and development as priorities; identify types of support needed most by stakeholders; Adopt farmer-based participatory experimentation and complementation of indigenous knowledge with scientific know-how; and streamline gender in CSA programmes. AU -NEPAD should strengthen its support to governments to enable them access funds from existing and new sources. Governments should improve funding for national research institutes, universities and ministries of agriculture. Governments should also work harder to see that extension services reaches out the majority of the farmers.

9.4 Variables/drivers that promote /hinder the adoption of CSA

The drivers for scaling CSA up are technology dissemination; communication and information; capacity building in CSA; social capital; appropriateness and profitability of CSA technologies; access to credit, inputs and markets; gender equity; strong government support both for policy and elaborating scaling up frameworks; overall national economic environment, finances from multiple sources and incentives for farmers.

Broad qualitative and quantitative indicators of agricultural productivity, human development and adaptive capacity of farmers are low. These indicators, refined in a participatory manner with stakeholders at the farm, community and national levels should be used to monitor and evaluate CSA interventions.

Recommendation

There is need to have a coordinated agenda towards CSA across Africa around capacity building of farmers, mobilizing finances, achieving political will, and strengthening institutions, research and development capacities.

9.5 Challenges and opportunities to scale up and out CSA

There are challenges in terms of inadequate policy, institutions, research/technology transfer and funding. The awareness at the community, national, regional and international levels of the negative impacts of climate change and the need to respond adequately are opportunities for promoting CSA.

Recommendation

Incentives to adapt CSA such as, fertilizer voucher schemes, access to credit and markets should be provided by governments and NGOs to farmers. Farmers should be provided assistance by government and NGO's to strengthen community groups. Governments should provide weather forecasts in easily useable forms and through suitable media, including radio networks accessible by rural communities. The capacity of national institutions working with community-based organizations and farmer based organizations to innovate and develop community action plans, preferably on a landscape (micro-catchment) basis should be strengthened.

9.6 Priority crops and livestock suitable for CSA practices in the different Agro-Ecologies

Various crop species are impacted by climate change to different degrees. The current situation is that positive responses to CSA have so far been reported for crops such as millet, sorghum, groundnut, rice, maize (mainly semiarid/sub humid zones), maize, rice and groundnut (mainly sub humid/ humid zone), which are important food and cash crops across Africa. Drought tolerant crop species and varieties should replace less drought tolerant ones in areas where rainfall is predicted to decline and the opposite where rainfall may increase. Also, it is desirable to develop varieties with some tolerance to salinity, flooding, drought and responsive to integrated soil fertility management. Little information is available on the response of livestock to CSA. Cattle are most important in the semi-arid zone, and small ruminants and poultry are important in all zones. Livestock, breeds that are relatively heat and drought tolerant should be promoted in all agro-climatic zones.

Recommendation

Information sharing across regions provides a rapid means in which technologies can be promoted. More attention needs to be given to improving the productivity and promoting breeds of small ruminants (sheep and goats) that can cope with harsh environmental conditions. Local breeds of livestock are relatively better adapted to heat and drought than exotic breeds. Artificial insemination systems that will result in breeds of cattle and small ruminants combining hardiness with productivity should be strengthened.

9.7 Gender Considerations

Women in rural communities of the three countries are particularly vulnerable to climate change because they are disadvantaged in rural communities. Gender is being taken into account in developing responses to climate change, but the efforts do not go far enough.

Recommendation

(i) Mainstream gender issues into agricultural development and climate change policies and programmes

(ii) Promote the amendment of laws or by the laws to improve women's access to land ownership

(iii) Create awareness raising programmes on CSA within communities and among those involved in rural development at local, regional and national levels targeting women.

(iv) Promote women's access to agricultural extension services and training, credit and inputs

(v) Promote access for women farmers to information about climate change, including weather forecasts

(vi) Promote women's access to CSA techniques

(vii) Strengthen women's organizations in rural communities and support their participation in the diagnosis of needs, planning, implementation and evaluation of CSA measures

(viii) Promote active female mparticipation in community decision making.

9.8 Conclusion

A range of stakeholders working in a coordinated fashion is required for successful CSA. They include extension services of governments and NGOs, national research institutions, CGIAR, regional and continental research and development organizations (FARA, ASARECA, and CCARDESA), and economic and political bodies / private sector, community and farmer based organizations and the individual farmers. The role of donor organizations is crucial for success.

References

ACTIONAID (2013) Walking the talk: Why and how African governments should transform their agriculture spending. Action Aid Policy Brief.

Akinbamijo Y (2013). The Contribution of the Forum for Agricultural Research in Africa (FARA) in Africa's Agricultural Transformation. Presentation at ASARECA General Assembly.

Banzi, F.M.; Otsyna R. and Assenga D., (2004). Soil fertility improvement and maize yields following woodlots of three different species in Shinyanga, Tanzania. In: Rao M.R. and Kwesiga F.R (Editors).

Carpano, T (2010). Strengtherning women's access to land. The Tanzanian experience of sustainable rangeland management project

Carpano, F (2011). Strengtherning women access to land into IFAD projects. The Rwanda experience.

Chapoto A and Jayne T S (2011). Zambian Farmers' Access to Maize Markets WORKING PAPER No. 57

Charness, G., and Viceiza, A.(2011). Comprehension and risk elicitation in the field: evidence from rural Senegal. IFPRI Discussion Paper 01135.

Chikowo R (2014). Application of the GYGA approach to Zambia

ChoiseAfrica (2013). NBDF-EU CBCCA Project Baseline Study: Nyagatare , Kirehe, Gatsibo and Bugesera districts Rwanda

Conway, D. 2002. Extreme Rainfall Events and Lake Level Changes in East Africa: Recent Events and Historical Precedents In E.O. Odada (ed.) The Second International Symposium on the Limnology, Climatology and Palaeoclimatology of the East African Lakes. Kluwer.

East Africa Farmers Federation (EAFF) 2014. 2014 Budget-Rwanda "Infrastructure development to accelerate export growth"

FAO (2010). Climate Smart Agriculture: policies, practices and financing for food security adaptation and mitigation. FAO, Rome

FAO (2012). Training Guide: gender and climate change research in agriculture and food security for rural development. FAO. Rome

FEWS-NET(2012). A climate trend analysis of Senegal. Famine Early Warning Systems Network-Informing Climate Change Adaptation Series. Fact Sheet 2012-3123. October, 2012. USAID.

FONERWA (2014). Make ways for the doers. Kigali.

FOOD SECURITY RESEARCH PROJECT LUSAKA, ZAMBIA September 2011. (Downloadable at: http://www.aec.msu.edu/agecon/fs2/zambia/index.htm)

Govereh, J., Jayne, T.S., Sokotela, S. L ungu, O.I., 2003. Raising maize productivity of smallholder farmers in Zambia: what can fertilizer consumption alone do or not do? Working Paper. Food Security Research Project, Lusaka, Zambia.

IFAD (2010). Marketing Infrastructure, Value Addition And Rural Finance Support Programme (MIVARF) Programme Design Report.United Republic Of Tanzania. Dar es salaam.

IFAD (2011). Republic Of Zambia Smallholder Productivity Promotion Programme (S3p) Programme Design Report Volume 1

IFAD (2014) Investing in rural people in Rwanda

IFDC (2013)Practices and Policy Options for the Improved Design and Implementation of Fertilizer Subsidy Programs in Sub-Saharan Africa. NEPAD Agency Policy Study. A joint publication by the NEPAD Planning and Coordinating Agency (NPCA), the United Nations Food and Agriculture Organization, and the International Fertilizer and Development Center (IFDC). Alabama. USA

Kalumanga V, Msaki M M, andBwagalilo F (2014). Climate Change Adaptation in Semi-Arid Areas: A Gender Perspective. International Journal of Ecosystem 2014, 4(2): 53-59 DOI: 10.5923/j.ije.20140402.02

Kato M (2001). Intensive cultivation and environment use among the Matengo In Tanzania African Study Monographs, 22(2): 73-91

Kissinger,G., Lee,D., Orindi,V.A., Narasimhan,P., Kinguyu, S.M., and Chase, S.(2013). Planning climate adaptation plans in West and East Africa and South Asia. CCAFS Report No 10. Research Programme on Climate Change, Agriculture and Food Security. CGIAR/CCAFS

Kuteya A (2013) Analysis of the 2014 Zambia's Agricultural Sector Budget. Presented at the ACF/IAPRI Budget Breakfast Meeting, Taj Pamodzi Hotel, Lusaka October 31, 2013

LENGALE Consulting Company LTD (2013). Documentation of the lessons and the best practices for climate smart small-scale agriculture

Lineger, M.P., MekdashiStuder,R., Hauert, C. and Gurtner, M(2011). Sustainable land management in practice-guidelines and best practices for sub-Saharan Africa.Terr Africa. Rome

Loada, A.(2014). The Comprehensive Africa Agriculture Development Programme Process in Burkina Faso (2014). From false start to restart towards rural development. Future Agricultures Working Paper 085

Makoi J (2014). Application of the GYGA approach to Tanzania

Mati, B. (2007). 100 ways of managing water for smallholder agriculture in Eastern and Southern Africa. A Compendium of Technologies and Practices. SWMnet Working Paper 13. 52pp

Memoire A (2010). Rwanda Agricultural Sector Investment Plan 2009-2012. FAO Technical Support Mission (1-12 February 2010)

Muhongayirea, W.Hitayezub, P. Mbatia O.C and Mukoya-Wangiad S M (2013) Determinants of Farmers' Participation in Formal Credit Markets in Rural Rwanda. J AgriSci, 4(2): 87-94 (2013)

NATIONAL ADAPTATION PROGRAMME OF ACTION RWANDA (NAPA RWANDA) MINISTRY OF LANDS, ENVIRONMENT, FORESTRY, WATERAND MINES, 2006. Kigali.

NATIONAL ADAPTATION PROGRAMME OF ACTION TANZANIA (NAPA TANZANIA).VICE PRESIDENT'S OFFICE, Division of Environment, January 2007. Dar es salaam.

NATIONAL ADAPTATION PROGRAMME OF ACTION ZAMBIA (NAPA ZAMBIA). MINISTRY OF TOURISM, ENVIRONMENT AND NATURAL RESOURCES, 2007.Lusaka.

NEPAD (2013) Zambia Agriculture Investment Opportunities Brief. CAADP Investment Facilitation Programme

NEPAD (2014). Tanzania Joint Sector Review Assessment. Advancing Mutual Accountability through Comprehensive, Inclusive, and Technically Robust Review and Dialogue

NEPAD (2014b). Financing Agricultural Sector Development In Tanzania

Nyanga P H, Johnsen FH, Aune JB and Kalinda TH Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. Journal of Sustainable Development Vol. 4, No. 4; August 2011

PMO and UCLAS (2003) Disaster Vulnerability Assesment Phase II. Dar es salaam

Rwanda Environment Management Authority (REMA) Guidelines for Mainstreaming Climate Change Adaptation and Mitigation in the Agricultural Sector (2011)

Selemani I S (2015) Influence of Ngitili management on vegetation and soil characteristics in semi-arid Sukumaland, Tanzania. Livestock Research for Rural Development 27 (2)

Simalenga T E (2013). Centre For Coordination Of Agricultural Research And Development For Southern Africa (CCARDESA)

Swai O W,Mbwambo J S, andMagayane FT (2012). Gender and Adaptation Practices to the Effects of Climate Change in Bahi and Kondoa Districts Dodoma Region, Tanzania. Journal of Sustainable Development; Vol. 5, No. 12; 2012

TaylorM., Dougherty J. and Unro R. M (2009) Zambia's Agricultural Finance Market – Challenges and Opportunities , Profit and ZNFU

Thornton, P., Herrero, M., Freeman, A., Mwai,O., Rege, E., Jones, P., and McDermott, J (2007). Vulnerability, climate change and livestock: research opportunities and challenges for poverty alleviation. Journal of Semi Arid Tropical Agricultural Research 4(1): 1-23

Trenberth, K. E., P. D. Jones, P. Ambenje, R.Bojariu, D. Easterling, A. Klein Tank, D. Parker, F. Rahimzadeh, J. A. Renwick, M. Rusticucci, B. Soden and P. Zhai. 2007. Observations: Surface and Atmospheric Climate Change. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York,NY, USA.

UNCTAD, Statistical Profiles of the Least Developed Countries 2013

URT (2011). Tanzania Agriculture And Food Security Investment Plan (TAFSIP) 2011-12 to 2020-21. Dar es salaam

Verdoodt A and Ranst E V (2013). A Large-Scale Land Suitability Classification for Rwanda. Land Evaluation for Agricultural Production in the Tropics. Department of Soil Science. Ghent University.

World Bank (2010) Climate-Smart Agriculture. A Call to Action.

ANNEXES

ANNEX 1: List of Contacted Persons

DidasKimaro	Sokoine Univerity of Tanzania
Elijah Phiri	University of Zambia
Frederick Baijukya	IITA Tanzania
Nathan Phiri,	ARI, Zambia
VeronikaUzokwe	IITA Tanzania
Zachary Malle	ARI Uyole - Tanzania
Francis Njau	Chololo Eco Village

ANNEX 2: Terms of Reference

OBJECTIVES OF THE ASSIGNMENT

The main purpose of the survey is to identify and document the best bet practices of climate smart agriculture that can be shared and scaled up in other countries in order to mitigate the effects of climate change on food security and livelihoods

Specifically, the survey will:

1. Identify, document and collect baseline data and information on successful climate-smart agricultural practices for scaling up and outscaling
2. Document and collect data and information on variables that promote climate smart agriculture
3. Identify existing gaps and investment opportunities where CSA can intervene within the CAADP framework
4. Determine the drivers, challenges or constraints that may facilitate or hinder scaling up and out of CSA practices in Africa
5. Ascertain the priority crops and livestock that are suitable for CSA practices across different agro-ecologies in Africa

OUTPUT AND DELIVERABLES

The consultant is expected to deliver the following outputs:

1. A detailed work plan for accomplishing the assignment giving a description of the methods to be used
2. A draft report that includes the following for review by the FARA Secretariat staff
    - A table of contents
    - An Executive Summary
    - Introduction
    - Methodology
    - Outcome of Baseline Surveys
    - Conclusions and Recommendations
    - References
    - Annexes
3. A detailed final report that incorporates comments/inputs from stakeholders to FARA Secretariat

About FARA

The Forum for Agricultural Research in Africa (FARA) is the apex continental organization responsible for coordinating and advocating for agricultural research-for-development. (AR4D). It serves as the entry point for agricultural research initiatives designed to have a continental reach or a sub-continental reach spanning more than one sub-region.

FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector and to mobilise themselves to respond to key continent-wide development frameworks, notably the Comprehensive Africa Agriculture Development Programme (CAADP).

FARA's vision: Reduced poverty in Africa as a result of sustainable broad-based agricultural growth and improved livelihoods, particularly of smallholder and pastoral enterprises.

FARA's mission: Creation of broad-based improvements in agricultural productivity, competitiveness and markets by continental-level strengthening of capacity for agricultural innovation.

FARA's value proposition: Strengthening Africa's capacity for innovation and transformation by visioning its strategic direction, integrating its capacities for change and creating an enabling policy environment for implementation.

FARA's strategic direction is derived from and aligned to the Science Agenda for Agriculture in Africa (S3A), which is, in turn, designed to support the realisation of the CAADP vision. FARA's programme is organised around three strategic priorities, namely:

- Visioning Africa's agricultural transformation with foresight, strategic analysis and partnerships to enable Africa to determine the future of its agriculture, with proactive approaches to exploit opportunities in agribusiness, trade and markets, taking the best advantage of emerging sciences, technologies and risk mitigation and using the combined strengths of public and private stakeholders.
- Integrating capacities for change by making the different actors aware of each other's capacities and contributions, connecting institutions and matching capacity supply to demand to create consolidated, high-capacity and effective African agricultural innovation systems that can use relative institutional collaborative advantages to mutual benefit while also strengthening their own human and institutional capacities.
- Enabling environment for implementation, initially through evidence-based advocacy, communication and widespread stakeholder awareness and engagement and to generate enabling policies, and then ensure that they get the stakeholder support required for the sustainable implementation of programmes for African agricultural innovation.

Key to this is the delivery of three important results, which respond to the strategic priorities expressed by FARA's clients. These are:

Key Result 1: Stakeholders empowered to determine how the sector should be transformed and undertake collective actions in a gender-sensitive manner

Key Result 2: Strengthened and integrated continental capacity that responds to stakeholder demands within the agricultural innovation system in a gender-sensitive manner

Key Result 3: Enabling environment for increased AR4D investment and implementation of agricultural innovation systems in a gender-sensitive manner

FARA's development partners are the African Development Bank (AfDB), the Canadian International Development Agency (CIDA)/ Department of Foreign Affairs, Trade and Development (DFATD), the Danish International Development Agency (DANIDA), the Department for International Development (DFID), the European Commission (EC), The Consultative Group in International Agricultural Research (CGIAR), the Governments of the Netherlands and Italy, the Norwegian Agency for Development Cooperation (NORAD), Australian Agency for International Development (AusAiD) and The World Bank.

Forum for Agricultural Research in Africa

FORUM FOR AGRICULTURAL RESEARCH IN AFRICA (FARA)
Forum pour la recherche agricole en Afrique
Headquarters 12 Anmeda Street, Roman Ridge
PMB CT 173, Accra, Ghana
Tel +233 (0) 302 772823 / 779421 **Fax** +233 (0) 302 773676
Email info@faraafrica.org **Website** www.faraafrica.org