State of Knowledge on CSA in Africa:

Case Studies from Nigeria, Cameroon and Democratic Republic of Congo

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Foreword

The evidence of climate change such as rising temperature and changes in precipitation is undeniably frequent in recent years with impacts already affecting 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 and 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 and 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 carbon emissions.

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

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

Identifying and documenting where successful CSA practices has been a challenge. With support from the Norwegian Agency for Development Cooperation (NORAD), FARA 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 in three countries, Nigeria, Cameroon and the Democratic Republic of Congo.

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

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Acronyms and Abbreviations

APRNET	Agricultural Policy Research Network
AU	African Union
CORAF	Consel Ouest et Centre Africain pour la Recherche et le Developpment
CAADP	Comprehensive Africa Agriculture Development Programme
CARE	International Cooperative for Assistance and Relief Everywhere
CC	Climate Change
CCAFS	Climate Change, Agriculture and Food Security
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture)
CIFOR	Center for International Forestry Research
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	La recherche agronomique pour le développement
COMNAC	National Committee on Climate Change
CORAF	West and Central African Council for Agricultural Research and Development
CSA	Climate Smart Agriculture
CSC	Ecological Monitoring Centre
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
ECOWAP	Economic Community of West African States Agricultural Policy
ECOWAS	Economic Community of West African States
ENDA	Energie Environnement Developpement
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
GCM	General Circulation Model
GEF	Global Environment Fund
GHG	Green House Gas

IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
IPCC	Intergovernmental Panel on Climate Change
LGP	Length of Growing Period
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
NARES	National Agricultural Research and Extension Systems
NARF	National Agricultural Resilience Framework
NASRO	North African Sub-Regional Research Organization
NASPA-CCN	National Adaptation Strategy and Plan of Action on Climate Change in Nigeria
NEPAD	New Partnership for Africa's Development
NERICA	New Rice for Africa
NGO	Non Governmental Organization
NORAD	Norwegian Agency for Development Cooperation
NSADP	National Sustainable Agricultural Development Plan
NSESD	National Strategy for Economic and Social Development
PNIA	National Agricultural Investment Plan
PNSR	National Programme for Food Security
PRSP	Poverty Reduction Strategy Paper
RARC	Rokupr Agricultural Research Centre
SCADD	Strategy for Accelerated Growth and Sustainable Development
SCP	Smallholder Commercialization Programme
SDR	Strategy for Rural Development
SLM	Sustainable Land Management
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WECARD	West and Central African Council for Agricultural Research and Development
WFP	World Food Programme

Executive Summary

The niche offered by Climate Smart Agriculture (CSA) is the triple possibility of simultaneously raising productivity, enhancing resilience and mitigating carbon emission. These three possibilities address existing challenges to agriculture in the African continent, which include in the least, the urgency of food insecurity, climate change, and related carbon emission. To effectively address these at the African level requires innovations, technologies and policy interventions that are knowledge-based. The Forum for Agricultural Research in Africa (FARA), with support from the Norwegian Agency for Development (NORAD) is facilitating research, policy and advocacy on CSA. However, in order to effectively do this there is need to understand the state of knowledge on CSA in Africa and possibly learn best practices that may be extended to various regions and farming systems in the continent. This study focused on three countries in the West and Central African regions – Nigeria, Cameroun, and the Democratic Republic of the Congo - is a component of an Africa–wide effort.

The goal is to provide baseline data on the status of knowledge on CSA in Africa. The objectives were to: (1) identify, document and collect data and information on successful climate-smart agricultural practices and actions for scaling up and out; (2) document and collect data and information on policies that promote climate smart agriculture; (3) identify existing gaps and investment opportunities where CSA can intervene within the Comprehensive Africa Agriculture Development Programme (CAADP) framework; (4) determine the drivers, challenges or opportunities that may facilitate or hinder scaling up and out of CSA practices; and (5) 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 and experts in agriculture and climate change, and (ii) review of literature on the socio-economic characteristics of farmers, food production systems, climate change adaptation and mitigation, and policies. Nigeria, Cameroon and the Democratic Republic of the Congo were selected considering the diversities in their Agro-ecological Zones (AEZ), farming systems, demography and socioeconomic characteristics.

The available evidence indicates that annual average temperatures have increased over the past three decades and predicted to increase further over the same period in the future. Rainfall regimes are also altered with differing characterization depending on locations over the same three decades. It is predicted to increase as well as decrease over the next 30 years depending on GCM model. These trends in general will have negative impacts on agriculture.

The dominant farming system is rainfed, while the area cultivated is small (<1-20 hectares) with soils of low fertility, and producing very low crop yields (cereal yields of 0.3-1.2t/hectare). Most farmers are poor and have not gone through formal

educational systems. Women form over 50% of the agricultural workforce while over 90% of households are headed by men. Access to agricultural credit and markets by both male and female farmers and ownership of land by women are poor. Consequently, farmers are very vulnerable with low adaptive capacity of farmers as a derivative of poor socio-economic circumstances, harsh biophysical environments, low technology, and poor infrastructure.

Analysis of documented evidences suggests opportunities for some practices that could be further developed and promoted. These can be seen as Best Bets and success stories of climate smart agriculture. 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 fit into this approach and 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 consistent with the triple parameters for CSA. Improved varieties of important staples such as cassava, maize, sorghum, millet, and rice have been developed from collaboration between national and international research organizations, and are available to farmers. Currently, more crop than livestock research and policy interventions exist. Livestock systems require improved technologies, improved livestock and forage production, improved genetic potential of livestock breeds, and control of animal diseases.

Research and development should improve productivity of present CSA-compliant technologies to mimic that of green revolution and enable farmers to adapt to and mitigate climate change. One area for future research should be developing methods for quantifying carbon under different farming systems and CSA technologies. This would encourage farmers to demonstrate their contribution to mitigating climate change and to participate in carbon markets.

Policies specifically on climate smart agriculture are lacking at national, sub-regional, and regional levels. However some countries have policies promoting green economy, while others have National climate change policies as well as strategy and adaptation plans which include issues concerning the agricultural sector. Some other countries have National Agricultural Investment Plans which include climate change adaptation or CSA components. These provide entry points for promoting CSA. However, an enabling policy environment for CSA to thrive is a challenge which should be addressed by governments. National, regional and international partners (NGOs, UN Agencies, CGIAR, AU-NEPAD, ECOWAS, FARA, CORAF/WECARD, 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.

There is the need to ensure effective flow of CSA information through highly skilled extension staff with targeted information packages. Extension of CSA technologies should be based on the development and use of innovation platforms. Considering the existing and emerging demographic patterns there is need to develop a new generation of youth farmers conversant with the philosophy of CSA. Gender issues must be taken into consideration in all aspects of scaling up and out of CSA.

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 farmers. Up-scaling, out-scaling and adoption of CSA is feasible in agro-ecological areas with similar characteristics, through information sharing including 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 National Agriculture and Food Security Investment Plans (NAFSIPs). Investments are required to develop CSA technologies and related research, set-up communities of practice 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.

Consistent with its mandate, FARA should lead the process to sensitize governments to have CSA-responsive policies and respond to regional and continental policies and agreements. Coordination is required to lobby governments to achieve buy-in as a major step towards widespread promotion of CSA. Governments will play critical roles in adoption of CSA through influencing policies and institutions that are key drivers to promoting CSA. There is need for the coordination of efforts towards CSA through sharing lessons and linking farmers to markets.

1. Introduction

1.1 Background

The hazards and associated risks of changing global climate are not abating (IPCC, 2014). In this context, and as is well acknowledged, agricultural activities in Africa are very vulnerable (NEST, 2011; Jalloh et al., 2013). Factoring climate change adaptation and mitigation into agricultural development planning and investment is therefore not optional for African countries. There exists opportunity for sustainable increase in agricultural productivity and enhancement of resilience to achieve reduced food insecurity and poverty (Thornton, et. al., 2006; Behnassi, et al,. 2014) through Climate Smart Agriculture. 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 (FAO, 2010; FMARD, 2014).

While there has been rapid uptake of the term Climate Smart Agriculture (CSA) by the international community, national entities and local institutions in recent years (FAO, 2013), there appears to be corresponding rapid adoption of such practices at farmers' level. The niche offered by Climate Smart Agriculture (CSA) is the triple possibility of simultaneously raising productivity, enhancing resilience and mitigating carbon emission (FAO, 2010). These three possibilities address existing challenges to agriculture in the African continent which include in the least, the urgency of food insecurity, climate change, and related carbon emission.

Implementing CSA approach could be challenging, partly due to lack of tools and experience. Two factors account for this. The first is that Climate-smart interventions are highly location-specific, while the second is being knowledge-intensive (FAO, 2013). The implication of this is that considerable research and policy efforts are required to make CSA more widely adopted. To effectively address this at the African level requires innovations, technologies and policy interventions that are knowledge-based. In a major effort to advance this, the Forum for Agricultural Research in Africa (FARA), with support from the Norwegian Agency for Development (NORAD) is facilitating research, policy and advocacy on CSA.

For such major efforts at altering the fortunes of farming systems in all agro-ecological zones and regions of the continent, it is important that there be quantitative impacts in the short, medium to long-term. Realistic demonstration of such impacts requires a baseline of existing practices in various farming systems, regions and countries. To effectively do this, there is need to understand the state of Knowledge on CSA in Africa and possibly learn best practices that may be up- and out-scaled within and between various farming systems and regions of the continent.

This study is a component of an Africa–wide study. Consistent with the imperatives of CSA as being location-specific, the study is split into components. This component focused on three countries in the West and Central African regions – Nigeria, Cameroon, and the Democratic Republic of Congo.

The main purpose of the survey (Annex 1 on Terms of Reference) was to establish a baseline of current status of climate smart agriculture in the three countries. The intention is to find such practices that hold the potential to be shared and scaled up. The specific objectives were to:

1. Identify, document and collect data and information on successful climate-smart agricultural practices for scaling up and out;
2. Document and collect data and information on policies 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 opportunities that may facilitate or hinder scaling up and out of CSA practices; and
5. Ascertain the priority crops and livestock that are suitable for CSA practices across different agro-ecologies.

1.2 Rationale

The study from which this report emerges, elaborates the state of knowledge on CSA in Africa. This has been done 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, CCARDESA, CORAF/WECARD), to carry out a baseline survey to generate data and information on Climate Smart Agriculture (CSA). The report provides information that could in the future be used to support evidence-based CSA policy, programme design and performance monitoring as a means of supporting accelerated scaling of CSA. This report should therefore, be a tool for planners, practitioners and policy makers. Importantly, it is a benchmark against which impacts of future innovations and interventions may be evaluated.

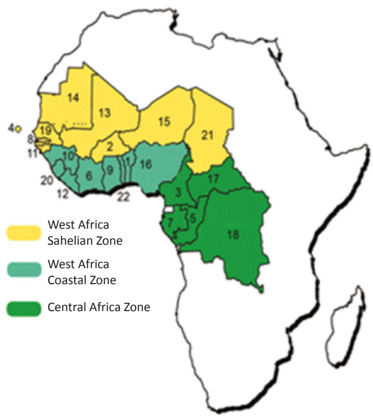
2. Methods

2.1 Inception Meeting

As part of a larger study on CSA in Africa, three countries located in West and Central Africa (Fig. 2.1) – Nigeria (16), Cameroun (3) and the Democratic Republic of Congo (18) (Figure 2.1) - were selected after an inception meeting at FARA secretariat in Accra in 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 study.

2.2 Study Area

Two key factors were considered in selecting the three countries. The first is the wide diversity of agro-ecological conditions, including the coastal environment, humid rainforest, and the dry savannas (Table 2.1). Nigeria has the arid/semi-arid, sub-humid and the humid areas from the North to the coastal South. Cameroon has the same three ecological zones as Nigeria, but with the humid highlands. DRC has the sub-humid, humid and the sub-humid highlands. The three countries are within the Gulf of Guinea, and between them harbor some of the most important forest areas of Africa, very important rivers such as the Niger and the Congo, as well as the Niger Delta and the Lake Chad. Consequently, the three countries were considered to be adequately representative of the main agro-ecological zones of West and Central Africa - the semi-arid, sub-humid and humid rainforest of West Africa, and the humid rainforest of Central Africa.



1. Benin - 2. Burkina Faso - 3 Cameroon
4. Cape Verde - 5. Congo - 6. Cote d'ivore - 7. Gabon
8. The Gambia - 9. Ghana - 10. Guinea - 11. Guinea Bissau - 12. Liberia - 13. Mali
14. Mauritania - 15. Niger - 16. Nigeria - 17. Central African Republic
18. Democratic Republic of Congo - 19. Senegal - 20. Sierra Leone - 21. Chad - 22. Togo

Figure 2.1 **The West and Central African regions with main agro-ecological zones**

Source: CORAF/WECARD

Table 2.1 The Agro-ecological zones of the selected study countries

	Arid/ Semi-arid	Sub-humid	Humid	Highland sub-humid	Highland humid
Nigeria	+	+	+		
Cameroun	+	+	+		+
Democratic Republic of Congo		+	+	+	

While Nigeria, Cameroun and the DRC have diverse farming systems with many crops and livestock, some are dominant. The cropping systems of Cameroon are mainly the Cereal root-crop (CR), Root and tuber crop (RT) and the Perennial mixed (PM) (Table 2.2). DRC is mostly Cereal root-crop (CR). Nigeria has the Maize mixed (MM), Cereal root-crop mixed (CR), and the Root and tuber crop (RT). These classifications are without prejudice to the existence of numerous other crops, livestock and wildlife, being areas of rich biodiversity.

The total population of 263.4 million in 2013 (Nigeria, 173.6 million; Cameroon, 22.25 million, and DRC, 67.51 million is a significant proportion of the human population in sub-Saharan Africa, which was 936.1 million. Jointly, the two factors of ecology and socioeconomics were considered a fair characterization of the continent to obtain baseline information on the state of CSA.

2.3 Sources of Data and Data Collection

This study employed a combination of methods, ie., desktop and interview of key informants. The desktop study sought and obtained information from policy documents and other sources, including peer reviewed journals, publications of national and international research organizations, published conference proceedings and consultancy reports. 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. There were also interviews with policy-makers, researchers and farmers organizations involved in designing and implementing agricultural development and climate change adaptation policies in the studied countries. Information and data were obtained on the socio-economic characteristics of farmers, food production systems, adaptation to climate change, mitigation of GHG emissions, CSA

and policies related to climate change, food security and rural development, climate change adaptation and mitigation, and on policies and national plans.

Table 2.2 The dominant farming systems in the selected countries

Country	Major Farming Systems[1]
Cameroun	CR,RT,PM
DR Congo	CR
Nigeria	MM, CR,RT

[1] The farming systems are defined as MM = maize mixed; CR = Cereal root-crop mixed; RT = Root and tuber crop; PM = Perennial mixed

The second factor for selecting these three countries is the socioeconomic conditions, especially demography (Table 2.3) .

Table 2.3 Socio Economic and Demographic Indicators of the Surveyed Countries

INDICATOR	Nigeria	Cameroon	DRC
Income	**Lower middle income**	**Lower middle income**	**Low income**
Population 2012	168.8 million	21.7 million	65.71 million
Annual ppn growth – 2012	2.1	2.082	2.579
Life expectancy 2011	52.3	55	48.7
Ppn density (per km^2) 2011	178.39	44.76	28.20
Fertility rate	6.017	4.859	5.6
GNI per capita ($) 2012	2,102	2270	319
Total Debt stock as % of GNI	2.8	17.1	21.9
Economic Vulnerability Index (EVI) 2012	38.6	23.4	37.34
Human Asset Index (HAI) 2012	48.9	45.5	21.7
Humanity development Index (2012)	0.471	0.495	0.304
Real GDP growth rate (2013)	5.4	5.5	8.5
Gross Capital Formation - % of GDP (2011)	16	21	21
Gross Domestic Savings - % of GDP (2011)	25.79	12.51	15.47
External Resource Gap % of GDP (Foreign direct investment, net inflows) (2011)	2.15	2.45	6.18
FDI inflows million USD 2012	7,101	525.75	2891.607
Share of value added (Agric/fish/ forests, hunting) (2009 – 2011)	22.29	23.57	22.02
Land Area (000)km^2	923.768	469.440	2,344.858
% Arable land and under permanent crop	7.4	3.3	0.357

Source : (UNCTAD 2013), Human Development Report 2013, WIKIPEDIA, http://data.worldbank.org/country/nigeria, http://www.worldbank.org/en/publication/global-economic-prospects/data?region=SST, http://data.worldbank.org/country/cameroon, http://data.worldbank.org/country/congo-dem-rep, World Development Indicators from World bank, http://www.indexmundi.com/democratic_republic_of_the_congo/demographics_profile.html, http://www.refworld.org/pdfid/54bcdca34.pdf, http://28toomany.org/media/uploads/democratic_republic_of_congo_-_general_statistics.pdf, http://www.tradingeconomics.com/cameroon/gni-per-capita-ppp-us-dollar-wb-data.html, http://data.worldbank.org/indicator/DT.DOD.DECT.GN.ZS, United Nations Economic and Social Council (2012). Report of the Committee on Development Policy on its Fourteenth Session, http://data.worldbank.org/indicator/NE.GDI.TOTL.ZS, http://www.ifdc.org/nations/democratic_republic_of_congo,

3. Climate Change and its Implications for Agriculture and Livestock Production

3.1 Climate change in Nigeria, Cameroon, and DRC

There has been a general increase in temperatures on the continent by over 0.5° C over the last 100 years (IPCC, 2013). Observed trends over several decades show that temperatures have been rising significantly in many countries, while rainfall has shown increases as well as decreases, depending on the ecological zone. IPCC (2013) reported that West Africa temperatures have risen by 0.2-2.5°C with stronger warming in the northern areas including Mali and Niger. Temperatures are predicted to increase on average by 2-3°C by 2046-2065. The highest daily maximum temperature will increase by 4-6°C and an average of about 0.2°C per decade. Yearly rainfall averages will increase across the region, with more extreme increases of up to 25% in the DR Congo. Across the selected African countries, climate has been changing over time as follows:

Nigeria

There have been changes in Nigeria's rainfall and temperature regimes (NIMET, 2014; FMEnv, 2011) over the past decade. Between 1941 and 1970, only patches of the country around the extreme Northwest and extreme Northeast experienced late onset of rains. From 1971 to 2000, late onset of rains had spread to most parts, leaving only a narrow band in the middle of the country with normal conditions. In the same way, only a small patch of the country in the South west recorded early cessation of rains between 1941 and 1970, while from 1971 to 2000, early cessation of rains had covered most of the country. The combination of late onset and early cessation shortened the length of the rainy season in most parts of the country. Between 1941 and 2000, annual rainfall decreased by 2 – 8 mm across most of the country, but increased 2 – 4 mm in a few places, most significantly around the coastal South east. With respect to temperature changes from 1941 to 2000, there was evidence of long-term temperature increase in most parts of the country. The central eastern axis showed slight cooling. Average temperature at the extreme northeast, extreme northwest and extreme southwest increased by 1.4 – 1.9°C.

Modeling of the future Climate of Nigeria

With respect to temperature, there is projection of warmer climate in the future where A2[1] scenario projects a temperature increase of 0.04°C per year from now till the 2046-2065 period (FMEnv., 2011). The coastal regions are projected to warm less than the interior regions because of the cooling effects of the Atlantic Ocean, and the northerly stations are expected to be warmer than the southerly stations. The highest increase is projected in the northeast, where the major geographical characteristic is the Lake Chad at the border with Cameroun and Chad Republic. With respect to rainfall, the projected changes in rainfall vary across the country, with the A2[1] scenario suggesting a wetter climate in the

[1] A2 refer to high emission scenarios

south, but a drier climate in the northeast. For the 2046-2065 period, the projected change ranges from an average increase of 0.4 mm/day in the south (15 cm annually) to an average decrease of 0.2 mm per day (7.5 cm annually) in the north.

Cameroon

Cameroon is characterized by five agroecological zones with varied landscapes and climates. These are described as Zone I (Soudano-Sahelian); Zone II (High Guinea Savannah); Zone III (Western Highlands); Zone IV (Humid Forest with monomodal rainfall pattern); and Zone V (Humid Forest with bimodal rainfall pattern) (Ndi, 2014). Records on temperature and rainfall from a number of stations in Cameroon suggest a rising trend in temperature around Yaounde (Ndi, 2014). Rate of temperature change since 1900 to 1991 showed a net increase of 0.91°C during the period that is higher than the global warming rate of 0.5°C over the same period. The Northern region of Cameroon has a Sahelian climate with annual rainfall (RF) ranging between 300mm to 500 mm and concentrated around three to four months from July to October with average annual temperature exceeding 30°C (Nchangvi, 2004).

A very prominent environmental feature of the West and Central Africa, concerning Nigeria and Cameroon is the Lake Chad that has important consequences for agriculture and fisheries. It sustains livelihood for farmers, livestock production especially cattle, and fisher folks. The health of the lake is therefore, very critical. However, there is severe decline in the size and use of the Lake Chad (Fig. 3.1). The declining area of the Lake has been partly attributed to declining rainfall and rising temperature in the region. In addition to Rivers Chari and Logone in Cameroun, the Lake Chad constitutes the major hydrological networks in the area. However, they all are disappearing and their flora and fauna are no exception (Epule, 2009). In 1964 when the Lake Chad Basin Commission was formed, the lake covered an area of about 25000km^2 (Epule, 2009). In 1993, it had reduced to 5000km^2 and by 2001 the lake only covered 3000km^2 square (UNEP, 2008; UNEP and DEWA, 2001).

Modeling of the future climate of Cameroon:

The predicted temperature in 2060 for Cameroon is 1.8°C as compared to predicted global temperature in 2070 of 3°C. With respect to rainfall, records show a general declining trend. When projected into the future, the trend shows decreasing number of rainy days in 6 out of 11 weather stations in the country. Total amount of rainfall reduces by 282 mm during the entire period. There is also drastic drop in total amount of rainfall in the northern region.

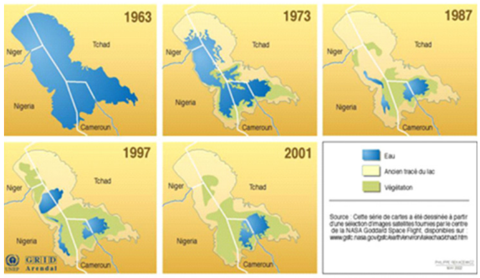


Figure 3.1 **The reduction in surface area of Lake Chad (1963 - 2001)**

Democratic Republic of Congo (DRC)

DRC is a country of abundant rainfall which ranges between 2400 mm and 900 mm per annum. The DRC has a tropical climate with two distinct seasons; the 'dry season' (18 to 27°C) called 'Congolese Winter', which is from June to August. The 'rainy season' (22 to 33°C) runs from September to May with its heavy monsoon rains. Temperatures are hot and humid in the central region, cooler and drier in the southern highlands, and cooler and wetter in the eastern highlands (SADC, n.d; AfDB, 2013). The trends over the last few decades indicate rise in temperature.

Modeling of the future Climate of DR Congo

The projections show increase in rainfall and gradual rise in temperature. It is projected that there could be increase in rains in the Cuvette region, but a shortening of the rainy season the farther south, especially in the savanna belt (NAPA, p. 12). After 2010, in the Katanga region, the rainy season is projected to shorten by two months from 7 months to 5 months.

3.2 Impacts of Climate Change and Implications for Agriculture

Impacts and Implications for Cropping Systems

Temperature increases are likely to lead to increased evaporation. Exactly how large this increased evaporative loss will affect crop production systems depends on factors such as physiological changes in plant biology, atmospheric circulation, and land-use patterns. As a rough estimate, potential evapo-transpiration over Africa is projected to increase by 5-10% by 2050. Increased variability of rainfall (i.e., deviation from the mean and occurrence of El Nino events) for crop production is also a major concern of farmers in Africa. Researchers have correlated past El Nino events and warm sea surface temperatures with more than 60% of the change between above and below average agricultural production of maize (Patt, et *al*., 2005).

Small-scale food crop production in all the regions of Nigeria, Cameroon and the DRC is heavily dependent on timing and length of the rainy season. This is strongly dependent on and directly influenced by the movement of the Inter-Tropical Convergence Front. This subjects the regions to a pronounced seasonality with four to six months of rainy season, in which most of the rain-fed food crop production takes place, and six to eight months of dry season with no opportunities for non-irrigated food production (Yengoh, *et al*., 2010). Food production among small-scale farmers is, therefore, very dependent on the reliability of the onset of rains and the distribution of rainfall during the rainy season (Yengoh, et *al*., 2010). Rain-fed agriculture is one of the most vulnerable livelihood and economic sectors to climate change in the these regions.

Since 1960, four major droughts and two floods have affected different parts of Cameroon's savanna zones with considerable effects on food production and human well-being (CRED, 2011). The frequency of weather-related crop failures in Nigeria's and Cameroon's savanna zones points to the vulnerability of food production in this region to future climate change. Crop yields diminish and livelihood is threatened (Figure 3.2). The vulnerability of this region mirrors the socio-economic impacts because of the importance of this region as a major production zone for cereals, pulses and livestock (Yengoh, *et al*., 2010).

While installed irrigation capacity is generally low in sub-Saharan Africa compared to that of many other regions (FAOSTAT 2010), climate change may further worsen the irrigation water supply of areas with installed irrigation infrastructure (Nelson, 2009). An appreciation of the expected impact of climate change to agricultural communities dependent on rain-fed production can guide policy-makers in designing strategies for mitigation and adaptation (Yengoh *et al*. 2010).

Figure 3.2 **Environmental degradation in the Savannah region of Northern Nigeria**

(Aisha's late husband owned the farm you see behind her. She has been living in this community for 50 years. She noted that trees have disappeared and there is less food for families to prepare. People are even leaving and moving out. She worries for the future and her family.)

Loss and reduction in crop yields, degradation of the ecosystem and loss of biodiversity are common features for all zones. In the arid and semi-arid areas (sahelian zones) as well as the rainforest and coastal regions of all three countries, there are manifestations of severe land degradation. While in the arid and semi-arid areas there are sand dunes and wind-induced degradation, in the rainforests and coastal areas there are very strong sheet and gully erosion and land degradation (Fig. 3.3). These lead to reduction in available cop land, lack of forage, reduction in numbers of livestock, and reduced incomes. Migration of men and youth takes place, and labour available for farming activities become scarce. In the sudano-sahelian zone, there is increased pressure on the land and frequent conflicts between crop and livestock farmers.

Figure 3.3 **Gully erosion - commonly found in the rainforest areas of the selected countries**

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 farmers' 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.

The diverse ecological zones of Cameroon reflect the country's array of climate regimes. The northern plains and Sudano-Sahelian zones are semi-arid, with a dry season that lasts for seven months, and have significantly higher temperatures in comparison to the rest of the country. The central and western highlands are cooler, with a shorter dry season. Conditions become more tropical in the south, with the southern tropical forest region being warm with a limited four-month dry season and the coastal tropical forest being warm and humid year-round. The wet season typically occurs between May and November, depending on the West African Monsoon winds blowing from the south-west (McSweeney, *et al*., 2008). Since the 1960s, mean annual temperatures have increased by 0.7”C and mean annual precipitation has declined by 2.2 per cent per decade. Rainfall was particularly low in 2003 and 2005 (McSweeney, *et al*., 2008).

Increase in temperature and decrease in rainfall (RF) are likely to bring about persistent droughts which will herald further food shortages and declining water resources in the Sahel. During the next 100 years temperature rise of 2°C to 6°C degrees is projected with a parallel decline in RF. Historical climate data for Cameroon showed warming of approximately 0.7°C over Africa in the 20th century, with noticeable decreases in RF over large parts of the Sahel. Future warming of the Sahelian Cameroon shows a temperature range of from 0.2 degrees Celsius per decade to more than 0.50°C per decade (UNEP, 2005).

Climate remains a key uncertainty for agricultural production in the Sahel of Cameroon. In 1997, low RF resulted in starvation, malnutrition and poverty which attracted a lot of food aid in the region from the World Food Program (WFP). In 1998, the WFP gave another 9500 tons of food to subvert shortages in the Northern part of Cameroon (Epule, 2009). This was again repeated in 2005 following drops in agricultural output (Molua and Lambi, 2006). The observed decline in RF in Cameroon is said to increase desertification in Northern Cameroon which enhances the effects on agriculture and water resources (Molua and Lambi, 2006).

Current projections suggest that Cameroon will experience a moderate increase in temperature this century: 1.0 to 2.9°C by the 2060s and 1.5 to 4.7°C by 2090s. Warming is expected to be faster in the interior and slower in the coastal areas, and to reflect an increase in the number of “hot” days and nights and a decrease in “cold” days and nights (McSweeney, *et al*., 2008). Although temperatures will rise, there is no consensus among climate models on projected mean annual rainfall. Models are, however, consistent in projecting increases in the proportion of total annual rainfall that falls in heavy events (-2 to +15 per cent) (McSweeney, et *al*., 2008). This could have an impact on flooding. Sea level rise is also a concern for Cameroon. Depending upon future emissions scenarios, it is projected that the coastal areas of Cameroon could experience a rise in sea level of between 0.13 and 0.56 meters by 2090 (McSweeney, *et al*., 2008). By 2100, sea level rise could lead to the displacement of 580,300 people and the destruction of 39,000 homes (CMEF, 2005).

Given these projected changes in climate, Cameroon identified a number of key vulnerabilities for two of its regions and for the health of its people within its First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) (CMEF, 2005). Concerns within its coastal zones include the potential for sea level rise to adversely affect mangrove forests by causing flooding, coastal erosion, sedimentation, and increased salinity. Along with the change in temperatures, this process could change the mangrove ecosystem and the flora and fauna contained within it—and by extension affect the local shrimp fisheries. Sea level rise is also expected to cause saltwater to intrude the Dibamba and Wouri Rivers, and into coastal aquifers, negatively impacting agriculture industries. Coastal infrastructure is also at risk. The Douala airport, due to its position at low altitude, could be threatened, particularly with the loss of mangrove forest protection. As well, there is the potential for increased sedimentation at Douala's port. Overall, Cameroon estimated in its 2005 National Communication that its coastal industrial properties were at risk of experiencing up to 2.74 billion CFA in damages due to climate change by 2100 (CMEF, 2005).

There is a drastic loss of trees which has devastating consequences on land due to loss of the vegetative cover. This has exposed the land to sun and wind, reducing the fertility of the soil and its ability to absorb and retain water. In the Sahel region, crops were shredded and buried by wind- blown sand. Insects and birds that protect edcrops from pests lost their habitat and their population declined. This led to plagues of pests, crop losses and low yield in both crop and livestock, which contributed to hunger. Women and children have to travel a long distance in search of firewood. The use of crop residue, which should be used for crop fertilization for cooking, deprives the farmers the only source of manure (Neate, 2013a; 2013b). Most varieties of crops, e.g. maize, are being affected drastically by drought. Heavy rainfall in some regions of Cameroon has washed away newly planted crops and left the farmer with no crops.

In Cameroon's interior Sudano-Sahelian zone, agricultural productivity is already expected to grow at a slower rate than population. Agriculture and livestock production will be most affected by any future changes in temperature, with agriculture production projected to decrease by between 10 and 25 per cent depending on the warming scenario (CMEF, 2005).

Impacts and Implications for Livestock Systems and Fishery

In the Northern regions of Nigeria and Cameroon which is Sahelian, climate change has affected an already highly vulnerable population. The main repercussions are declining water quantity and quality as well as declining agricultural output (Ntayike, 2004). According to Adama (2006), the most severe impact is that it has led to the drying of river beds, with animals and humans fighting for the same source of water (Epule, 2009). Climate change has contributed to change over time in transhumance patterns in arid and Semi-arid zones (Msangi 2014), which are the dominant ecologies of Northern Nigeria and Northern Cameroon. There are, however, few models dealing with livestock and none that deal with heat or water stress, which are crucial for the pastoral communities (Msangi, 2014). There is, also generally, less research dealing with climate change and livestock compared with cropping systems. This is one area for intervention. Lessons from Burkina Faso, Tanzania, Kenya, Ethiopia and Senegal show that impacts on the semi-arid livestock systems are projected to be greater compared to areas that receive higher rainfall. Climate change is responsible for the emerging and increase of pests and diseases. Drought and rising temperature also lead to shrinkage of rangeland resources (water and quality and quality of forage), exacerbating conflicts between livestock keepers and farmers (URT 2007). 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 resulting from climate change.

Fishery, especially freshwater, is an important livelihood in the southern coastal regions of Nigeria, Cameroon, and the DRC, which are located by the Atlantic. Climate change may also impact fisheries that have critical thermal maxima and cannot survive temperatures that exceed this threshold. Though tropical fishes can endure temperatures very near their temperature threshold, a slight (1 – 2°C) increase in regional temperatures may cause the daily temperature maxima to exceed these limits (Roessig *et al*., 2004).

Implications for Markets, Finance and Policy

Change in crop and livestock production due to climate change ultimately affects trade. Regional and international trade flow patterns for key agricultural commodities could move from countries of higher agricultural yields and comparative advantage to countries of lower yields and comparative advantage. Recent focus on developing agricultural value chains, expanded trade and marketing could be impacted by changing climate effects on agricultural productivity. Improved access to markets both locally and internationally, would provide a driving force for increasing agricultural productivity. However, this is yet an unexplored area for research and policy on climate change. For instance, the impact of climate change on total factor productivity in various farming systems is not sufficiently understood and requires. The dimensions of this include production, risk management strategies, financial support in the form of investments and smart subsidies for the poor small scale farmers to enable them adopt CSA.

Impacts and Implications for Gender

IPCC (2007) notes that from the point of view of gender, there are individuals and groups within all societies that have insufficient capacity to adapt to the impacts of climate change. The elements of adaptive capacity are socially differentiated along the lines of age, ethnicity, class, region and gender. The report argues further that, there are structural differences between men and women which make it difficult for them to adapt to the effects of climate change. According to the Skeggs (1997), these differences affect the capacity and ability of women and men to adapt. Women involved in subsistence farming are more burdened with the cost of coping and recovering from the effects of climate change and land use, and are disproportionately burdened with the expenses of recovering and adapting to droughts (Epule, 2009).

Climate change affects women directly through changes on water availability, fuel wood availability, and vegetation management where they play those roles. When these resources get scarce, women are the most affected since they will have to work extra hard or cover longer distances to fetch wood and water. Severe impacts of climate change on the northern parts of Cameroon leads to the drying of river beds, and women and children (essentially the poor) having travel longer distances to fetch water (Adama, 2006). Vulnerability of women farmers in Nigeria, Cameroon and

DRC is affected by their relative insecurity of access and rights over resources and sources of wealth, such as farm land. The women are disadvantaged in terms of property rights and security of tenure (Epule, 2009). The vulnerability of women is also associated with the fact that cultural norms ensure gender discrimination which does not permit women to participate in decision making on issues that may be relevant to them.

3.3 Conceptualizing CSA in sub-Saharan Africa Context

Climate Smart Agriculture (CSA) globally is characterized by the simultaneous raising of resource use productivity, resilience to changing climatic conditions, and mitigation of carbon emission (FAO, 2010) (Fig. 3.4). The challenge is to identify and extend such innovations and existing practices that simultaneously attain these three parameters. It is however, important to relate this global understanding of the concept to CSA to the realities of the conditions of farming systems in various regions of sub-Saharan Africa.

The first condition is the low resource productivity that characterizes most farming systems in all regions in Africa. Low resource productivity implies constrained economic viability of agricultural production. This is implicated in the dominance of smallholder subsistence producers and the minimal emergence of agribusiness with significant relationship to the market. With rapidly changing demographic conditions including rising aggregate population, sub-Saharan Africa's population is expected to rise from 800 million in 2007 to 1.5 billion by 2050 at the current growth rate of 2.3% (UNDESA, 2013) and high rural to urban migration (for instance urban population in Nigeria exceeded 51% by 2014). This partly accounts for the core problem of poverty and food insecurity (60% of Nigerians were food insecure in 2014). The factors responsible for low resource productivity include low technology and management capability. While research, extension, advocacy and policy activities have focused on raising farm productivity through biotechnology, input provision and farmer capacity development, this has not met with significant success. The agricultural sector is therefore in dire need of innovations, technologies and management to raise productivity.

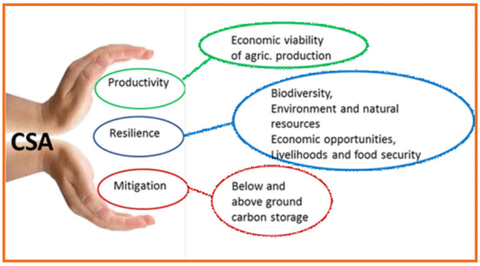


Figure 3.4 **Conceptual presentation of CSA dimensions and characteristics**

The second condition is the low resilience to climate change by most farming systems in most regions of Africa. Climate change is an added burden to the existing low productivity scenario, and expected to reduce agriculture by 30% with current trends (NEST, 2012). While Africa contributes little to global warming, a key factor in climate change, most African countries already bear most of the burden. At least three characteristics of climate change in Africa are identified. These are rising temperature, changing precipitation regimes, and increased frequency of occurrence of extreme weather events. The diverse ecological characteristics of the continent, with some very dry areas with high temperatures, changing precipitation regimes, and increased frequency of occurrence of extreme weather events, exacerbates the challenges of the farming systems in most regions in Africa. The science of climate change teaches that today's characteristics are products of several years' endogenic activities. This suggests that the consequences of today's actions lie very far in the future, and therefore makes the case for adaptation and developing the resilience of farming systems. Since however, global temperature is still rising and carbon emission still above threshold, African agricultural systems require developing capacities to adapt, to raise resilience. Developing resilience requires technologies and innovations that address biodiversity, environmental and natural resources management, alternative economic opportunities and livelihoods, while ensuring food security.

The third condition is the extent to which existing farming practices contribute to mitigate climate change. This includes practices which sequester carbon, or at the least do not contribute to carbon emission. Most current farming practices commencing from land preparation, tillage, deforestation, etc., are some of the most important ways farming systems on the continent contribute to carbon emission.

The three conditions are a challenge to research and policy in Africa, considering the urgent need to raise productivity, address food insecurity and poverty. The simultaneous existence of these three may be considered normative. The positive situation, however, may be different. Where there is paucity of innovations and lessons of practices which achieve these three conditions simultaneously can these parameters be prioritized? Can it be acceptable that there is an order of ranking of these three following their relationships to addressing the urgent challenge of food insecurity and poverty in the continent? Can it be accepted that the most urgent in the African context is to raise productivity and can therefore be treated as a necessary but not sufficient condition for an innovation or practices to be classified as Climate Smart? Would it be feasible to accept as CSA any innovation or practice which must raise productivity in addition to either being resilient or mitigates?

There are two critical characteristics common to most farming systems in Africa. These are the dependence on rainfed systems, perhaps as a result of minimal irrigation capacities. Therefore changing rainfall regimes have severe implications for African farming systems. The second is low mechanization and heavy reliance on human labour as the most important source of farm energy. In farming systems where rainfall regimes are changing, at least two issues are important. These are biotechnology to develop drought resistant varies and breeds of livestock, as well as short growing crops varieties. These aspects are well focused on by research institutes and researchers. The second is the heavy reliance on human labour. With rising temperature, there is the likelihood of low labour productivity. This should also factor in the reality of aging farming population and huge youth rural to urban migration. However, there are not much research and policy interests in the implications of climate change, rising temperatures and the productivity of farm labour in low mechanized/low technology farming systems. So far this is not the focus of research and policy on climate change. It is very critical in the African context that CSA should incorporate innovations which address the challenge of rising temperature and human labour in farming systems using low mechanization.

4. Successful Climate-Smart Agricultural Practices

4.1 Adaptation and Mitigation Practices in Use

Nigeria

Climate Smart Agriculture in its comprehensive form is not yet a government policy, neither is it deliberately practiced by farmers in Nigeria. However, elements of CSA are implemented by farmers who do not consciously regard them as CSA practices. The basis for this assertion is that they aim at improving production/food security, while enhancing adaptation and mitigation.

Some examples of such practices that hold potential for scaling up and out are listed in Table 4.1. They are also arranged according to different agro-ecological zones of Nigeria, including the coastal, rainforest and savannah. Most of these practices are relevant to crop production. Certain agricultural practices that are climate smart include Run-off water harvesting, Agroforestry and Conservation agriculture, which are essentially based on the principles of soil conservation. Besides the technological options, climate risk management techniques such as seasonal weather forecasting, index based insurance and safety nets, could be promoted.

In most communities in Nigeria, farmers are actively engaged in climate change adaptation activities in an attempt to relate to the changing environment. For example, between 2008 and 2011, the Nigerian Environmental Study Action Team, under the Building Nigeria's Response to Climate Change (BNRCC) Project carried out a number of pilot projects involving support of climate change adaptation initiatives in communities across the major ecological zones of the country. In these communities, people were engaged in a wide range of climate change adaptation activities, including water harvesting, construction of earth dams, dry season irrigation, adoption of improved seeds and early maturing crops, use of fuel efficient woodstoves, bee keeping, snail farming, tree planting, use of simple weather forecasting tools, erosion control, sand dune stabilization, establishment of fodder production farms, and fish farming (FMEnv, 2011). Community-based participatory climate smart village approach involving climate risk management should be promoted.

Beside those listed in Table 4.1, some other Climate Smart Agricultural practices were identified. These include but are not limited to:

a) Conservation Agriculture (CA) which aims to conserve, improve and make more efficient use of natural resources through integrated management of soil, water and biological resources combined with external inputs (FAO, 2000).

Table 4.1 CSA Practices for Scaling up and out in various AEZ of Nigeria

AEZ	CSA RELEVANT PRACTICE
Coastal	Adjusting of planting dates. Use of drought resistant varieties, Planting of cover crops to increase soil fertility e.g. legumes. Incorporation of residues or other mulches reduces wind and soil erosion, increases water retention, and improves soil structure and aeration • Use of drought resistant varieties, use of improved varieties tolerant to climate change stressors e.g. rice and maize hybrids. Use of salt tolerant Varieties (e.g. Ex-Dakar cultivar of groundnut).
Rainforest	Use of drought resistant varieties, Use of improved varieties tolerant to climate change stressors e.g. rice and maize hybrids. Use of salt tolerant Varieties (e.g. Ex-Dakar cultivar of groundnut. Reduced tillage. Mixed farming practice e.g. Poultry, fish pond and crop farming. The poultry dung serves as feed for the fish while the polluted pond water serves as manure for the crops. Planting of cover crops to increase soil fertility e.g. legumes. Crop residue management increases soil organic matter content, water retention and improves soil structure and aeration. Mulching protects against wind and soil erosion
Savannah	Rain water harvesting, and Run off water harvesting, use of Fadama land (wetland), and Resort to irrigation • Rearing of improved breeds of livestock e.g. white coloured sheep was identified to control heat stress (Fadare, et. *al*., 2012) • Rotational Grazing, Stocking density management (e.g. herd size/ land area), Improved feed management (higher feed quality), Use of industrial by-products and livestock feed, use of ethno-veterinary medicine, application of herbs to livestock diseases, and Use of forage obtained from hedgerows and compound farms • Agroforestry, Planting Crop varieties with early maturity, Drought resistance species, and Use of mulching for young seedling, Addition of fertilizers, intercropping with leguminous crops, addition of manure
Sahel	• Construction of dams, Run-off water harvesting, and Construction of waterways to manage flooding • Agro-forestry, Planting of crop varieties that are tolerant to variable rainfall patterns (soya bean, upland rice), Resort to irrigation, and use of fadama land (wetland) for crop production. Minimum or no tillage, and Rotational cropping • Grazing land improvement, Improved breeding, Stocking density management (e.g. herd size/land area), Improved feed management (higher feed quality), and Manure management (barn design)

Sources: Field survey responses, 2014; Abiodun, B.J., Salami, A.T. and Tadross, M. (2011); NEST and Woodley 2012; NEST, 2011; FMEnv, 2011

The three core principles of Conservation Agriculture are permanent residue soil cover, minimal soil disturbance (direct seeding) and crop rotation (Speranza, 2010). Minimal soil disturbance contributes to maintaining soil carbon and crop rotation reduces susceptibility to crop specific pests and diseases. These three principles are crucial for climate change adaptation in agriculture and mitigation .

b) Integrated Crop Management (ICM) can be understood as a compromise between organic production and conventional production. ICM evolved to address perceived problems with conventional production such as environmental pollution from herbicides, pesticides and inorganic fertiliser use. While organic agriculture uses only organic inputs, ICM uses both organic and inorganic inputs but aims for efficiency in input use in a way that avoids harm to the environment. Thus such an approach is expected to contribute to environmental and climate protection. In all the AEZs in Nigeria, ICM is practiced. Farmers use a combination of both organic and conventional production to boost their productivity.

c) Organic Agriculture which includes practices like crop rotation and the use of cover crops, nitrogen management and fertilisation regimes (planting of nitrogen fixers like groundnut), use of oil palm tree residues as manure for its high content of potash, are used in the rain forest Zone of Nigeria.

d) Agricultural Water Management (AWM) in which case water from different sources (rainwater, surface, and groundwater) can be used for crop and livestock production (including aquaculture). AWM systems can be classified into various categories (FMARD, 2014): Run-off water harvesting and management: On-farm storage for supplementary irrigation, Soil and water conservation, Run-off diversion and spreading, Spate irrigation, Wetlands farming – valley bottoms or flood recession cultivation (e.g. Fadama, land drainage Interventions), Stream diversion for smallholder irrigation, using either gravity or pumps, Various irrigation technologies (low-head drip, sprinkler, furrow and basin, micro systems), Soil management and fertility improvement, and Conservation agriculture (conservation tillage, crop residue management, agro-forestry, etc).

e) Indigenous Knowledge (IK) also known as local knowledge refers to knowledge held by the local people, outside the formal scientific domain (Odero, 2011). To cope with the negative impacts of climate change, communities employ traditional/ local and indigenous knowledge based practices. Farmers in the rainforest AEZ in Nigeria make use of IK in forecasting the weather conditions for proper timing of their planting. In the Bauchi area of North central Nigeria, farmers estimate early or late commencement of rainy season by the height at which birds chose to nest on trees (Fig. 4.1). When the nests are located high up on trees, this indicate late commencement of rains while nesting below, indicate early commencement of rains. Though such IK may not be one hundred per cent correct, it has over the years guided most of the farming practices in most of the AEZs in Nigeria. Indigenous knowledge can be successfully used to strengthen farmers' adaptive capacity to climate change. Luseno, et al., (2003) suggest that indigenous climate forecasting methods can offer insights to improving the value of modern seasonal forecasts for pastoralists. This is because indigenous forecasting methods are need-driven, focus on the locality, on the timing of rains, and indigenous forecasts are 'communicated in local languages and typically by "experts" known and trusted by pastoralists'.

Figure 4.1 Location of bird nesting on trees

f) Adapted Crop Varieties provide benefits primarily in terms of adaptation to the effects of climate change. Improved high yielding drought tolerant varieties of cereals, grain legumes, roots and tubers with tolerance to major disease and pests developed by national programmes in partnership with CGIAR centres are used in all agro-climatic zones and countries. They give yield increase often more than 100% over local varieties. Well known examples are NERICA (upland rice) and drought-tolerant maize varieties. These improved varieties used in conjunction with the Sustainable Land Management practices improve yields and productivity considerably and is available for maize, millet, sun flower, sorghum and cassava.

g) Case Study: Micro Check Dam for water harvesting on seasonal streams in Ibadan, South West Nigeria (Fig. 4.2). A Micro Check Dam is a small embankment structure built or placed across a stream or small river to retain and store runoff within a pond excavated for that purpose. This simple technology has been implemented at numerous sites by farmers in the South Western part of Nigeria with the assistance of hydrologists and engineers at IART. The water conservation benefits are obvious and farmers testify that Micro Check Dams assist them greatly, particularly during extended breaks in rainfall in the rainy season. In many watershed and agricultural land-use areas in Nigeria, there are several seasonal streams and rivers that are not major in their capacity and thus are often ignored as reliable source of agricultural water supply. With adequate water harvesting systems, the yield or discharge of such streams can be harnessed to become a source of agricultural water supply at low cost and minimum technological skills. The Institute for Agricultural Research and Training (IAR&T) Ibadan, developed the Micro Check Dam Technology for water harvesting and storage to make water available to farmers for either supplementary irrigation or total irrigation agriculture during the dry season and also to water livestock during the dry season.

Cameroon

As with the case with Nigeria, there are no explicit policies and practices defined as CSA in Cameroon. However, there are practices which aim to increase productivity, adapt to climate change, and make minimal contribution to emissions. These are also related to sustainable management practices. These practices include sustainable agriculture practices that preserve soil fertility and maintain or increase organic matter [(examples are crop rotation, composting, green manures and cover crops which can reduce the negative effects of drought while increasing productivity (Niggli, *et al*., 2009)]. The water holding capacity of soils are enhanced by practices that build organic matter, helping farmers withstand drought (Altieri and Koohafkan, 2008; Borron, 2006). Conversely, organic matter also enhances water capture in soils, significantly reducing the risk of floods (ITC and FiBL, 2007).

Practices such as crop residue retention, mulching, and agroforestry conserve soil moisture and protect crops against microclimate extremes. In addition, water-harvesting practices allow farmers to rely on stored water during droughts and increase water availability. (Ensor, 2009).

Many of the above practices are inherent in ecological agriculture and easily implemented to play a prime role in climate change mitigation. Other practices include improved farming system design, improved cropland management, improved grazing-land and livestock management, maintaining fertile soils and restoration of degraded land, improved water and rice management, fertilizer management, land use change and agroforestry (Bellarby *et al*. 2008). These ecological agricultural measures for mitigating GHG emissions and adaptation potentials to climate change are summarised in Table 4.2. Most of the practices are self-sufficient in nitrogen due to recycling of manures from livestock and crop residues via composting, as well as planting of leguminous crops (Ensor 2009; ITC and FiBL, 2007). Moreover, practices rooted in ecological agriculture, such as introducing perennial crops to store carbon below the ground and planting temporary vegetative cover between successive crops to reduce N_2O emissions by extracting unused nitrogen also mitigate climate change (Ensor, 2009).

Some other practices by farmers that can be considered as CSA-compliant. These include:

a) Use of organic fertilizer such as forage legumes/ grass mixture and composting: The use of organic fertilizer impacts positively on productivity, return to labour and capital. Schlechtet, al., (2006) pointed out the benefits of crop residue restitution to soil organic matter content, water holding capacity and agricultural productivity. The practice is therefore considered climate smart. In Cameroon, the western highlands are classified by the World Reference Base (WRB) for soil resources system as dominantly covered by andosols. In this region, andosols are characterized by their high content of organic matter and their good capacity for water retention. The reduced dependence on inorganic fertilizers has impacted positively to GHG emissions. This makes region the one of the main agricultural areas in Central Africa and is considered to have medium to high agricultural potentials (Bationo, *et al*., 2006). Soils are widely cropped (Sansoulet, 2007) and the fruits and vegetable market has been one of the main innovations of the farmers, following the coffee crisis of the 1990's (Kaffo, 2005).

Table 4.2 Some Agro-ecological practices with adaptive and mitigative potential used in Cameroon

Measure	Examples	Mitigative	Adaptation
Crop Management	Agroforestry Water management Tillage management Nutrient management Residue management	Naturally decaying residues improve soil organic matter structure and content (Moyin-Jesu, 2007). Residues may serve other purposes like being used for animal feed or straw. Introduce multifunctional trees into agro-ecosystems. Improve agro-ecosystem resilience	Optimize benefits from multifunctional uses of crop residues; Improve soil organic matter; Agricultural risk is diversified as agro-ecosystems become more resilient (Wojtkowski, 2008). It is effective in restoring disturbed land (Peng, *et al*. 2009)
Livestock integration and management	Improved feeding practices Specific agents and dietary additives	- Generate nutrients within farm systems; Improve the system and efficiency of nutrient cycling and flows; Creates a system that is less dependent on outside sources of fertilizers and more resilient to food crop natural and price fluctuations	
Manure management	Improved storage and handling Manuring More efficient use as nutrient source	Plant residue can become inputs into composting systems for organic fertilizers (Moyin-Jesu, 2007). Optimizes the flow of farm-scale biogeochemical processes	
Restoration of degraded lands	Organic amendments Nutrient amendments Maintaining soil fertility	Conserve soil structure - Conserve the top soil & soil organic Matter Sustains soil fertility and productivity (Baulcombe, et al., 2009)	
Grazing land management and Pasture management	Grazing intensity Fire management Nutrient management Cover crops planted	Reduced emission of GHGs	Increased productivity

b) **Agroforestry:** The use of trees and shrubs in agroforestry systems helps to tackle the triple challenge of achieving food security, mitigating climate change and increasing the adaptability of agricultural systems (Torquebian, 2013; FAO, 2010). In Babanki Tungoh village in North West region of Cameroon, the agroforestry practice is agrosilvo-pastoral system occupying 56% of land use practices whereas silvopastoral and agrosilvocultural systems occupied 25% and 19% respectively. In animal production systems, cow dung and pig waste provides biogas. (Vegah, 2014). Agroforestry has helped in: protecting the soil from wind and water erosion; acting as a sink for greenhouse gases emissions and protecting the environment from further desert encroachment and climate change.

c) **Intercropping, multiple cropping and crop rotation:** There are many different combinations of crops in different regions of Cameroon. The choice to use any of the above cropping systems by farmers are influenced by the following farm size, soil type; sloping or flat. Farmers use mixed cropping and also row intercropping, in a typical crop rotation, sorghum and cowpea are planted followed by cotton.

d) **Unreliable rainfall and temperature:** Dams have been constructed on the Logone, Benue, Mayo and Oulo rivers (Epule, 2009) to improve adaption to declining agricultural production through the use of irrigation. Other possible methods of adaptation include improving water use efficiency by indigenous water harvesting of scarce precipitation from larger less productive zones to smaller areas where commercially viable crops, shrubs, trees can be grown under normal prohibitive amounts of rainfall (Thomas, 2008). This may also be achieved through systems of irrigation such as the sprinkler and drip irrigation which are more efficient in the use of water. In areas where about 95% of water withdrawal is used for agriculture, simple methods such as a move from the wasteful surface furrow irrigation to alternate furrow irrigation can result in huge water savings of up to 30 % and yields increases of 15-20% (Thomas, 2008). Adapting livestock production to water scarcity: As concerns livestock farming, adaptations to water shortages and high temp can be possible due to supplementary feeding by fodder, rotation of pasture and altered grazing, development of new heat resistant varieties of livestock (IPCC, 2007). On a long term note, the IPCC, (2007) argues that adaptation can be possible through the planting of trees, commercializing and diversifying livelihoods (Epule, 2009).

e) **Late planting:** In the event of delayed rainfall in most zones, crop farmers engaged in late planting for a month and repeated planting of crops in response to the erratic rainfall. This was an innovative strategy for maize, millet and *Cucurbitaceae (Cucumeropsisedulis)* and other cereal crop cultivators.

f) **Blocking of drainage:** In most rice farms in the northern plains of Cameroon, prolonged dryness compelled farmers to block drainage outlets in order to maintain some degree of water logged/ moisture within the farms (ATPS, 2013).

g) **Grazing on Leftover Straw and Harvest of Animal Droppings:** Continuous eruption of conflict between rice farmers and cattle grazers over the use of available land has led to a system where rice farmers allow grazers to feed their cattle on left over straws after harvest. In return, droppings from grazing cattle aid in fertilization of farms. This innovation has contributed to reduced socioeconomic conflicts between the farmers and grazers in the wetland plains of Cameroon which is characterized by seasonal variations in precipitation. Livestock farmers use high nutritional content trees for fencing providing another source of animal feed.

h) **Multiple Cropping and Planting with Different Maturity Period:** Food crop farmers have developed multiple cropping and planting of species that mature at different periods so as to compensate for the late maturing species, crop failure and ensure continuous food supply. In Monomial agro-ecological zones of Cameroon, rotational cropping is practiced with maize harvested in July, August and September, followed by land preparation for beans planting.

i) **Wood Ash application:** During land preparation and planting, farmers apply wood ash on the soils as a local insecticide to prevent the destruction of the germinating seedlings.

j) **Urban Cropping:** Limited availability of post-harvest preservation techniques undermines the supply of food and vegetables from the rural settlements to the urban areas. Most urban households have replaced flower gardens with small scale gardens that act as source of vegetables. Furthermore, ornamental trees are now giving way to fruit trees and permanent crops like plantains. Formerly market gardeners used to nurse seedlings in the last two weeks of September to transplant them in the first two weeks of October. Faced with the exigencies of climate change (especially prolonged rains), the nursing period has moved from the last two weeks of September to the last two weeks of October with effective transplanting of seedlings in November. Digging and opening of irrigation channels is done in the drier months of December and January.

k) **Shade trees:** Perennial crop farmers (palms, cocoa, coffee etc.) confronted with the problem of prolonged dry spells are now leaving shade trees in their farms to screen their plants from the sun.

l) **River bank farming:** Cocoa and coffee farmers are concentrating new farms along river beds as a means of guaranteeing moisture supply during dry seasons. Palm farmers prune their farms and use the pruned leaves as mulch, a practice that helps the palm trees survive through long dry periods.

m) **Aeration and Treatment:** Most micro-organisms that attack cocoa and coffee pods proliferate during prolonged rains. Farmers use fungicides to curb the microbial load of the farms. Regular cleaning of farms increases aeration, contributing reduced microbial load in these farms.

n) **Switching crop varieties:** As an ex ante adaptation strategy, subsistence farmers in Cameroon have developed the tendency of switching crops varieties as climate changes. They seek to grow crop varieties that are with different sensitivities to climate.

o) **Changing of planting dates:** Farmers in the Sudano-Sahel have an anticipated adaptation measure for which adaptation actions to climatic variability and change are taken. Their dependency on rain-fed agriculture makes them maintain flexibility with regards to input decision until uncertainties about weather realizations are reduced. For instance by shifting planting dates. Shifts in planting dates are usually aimed at minimizing the effect if temperature, induced spikelet sterility that can be used to reduce yield instability by avoiding coincidence of the sensitive flowering stage with the hottest part of growing season (Sparks *et al*. 2000).

p) **Crops to livestock switch:** Since rain fed crops are constrained by the harsh climate, it is apparent expanding at the expense of livestock numbers, which are more or less sensitive to climate factors. To supplement the recent shifts from crop to livestock as a perceived adaptation strategy, the increase use of cotton cake as feed for cattle has increased. The presence of parastal organization Société de développement du coton du Cameroon (SODECOTON) operating in the North and the Far North regions provides a constant supply of these feeds (Somar, 2013).

q) **Soil conservation strategy:** Soil conservation is perceived by farmers as another adaptive strategy. They use fallow cow dung after decomposition serve as source of nutrients for the household crops. Other practices include the use of farm yard manure, crop rotation, green manure, crop covers, mulching and agro-forestry residue retention. These practices are inherent in ecological agriculture and can reduce the negative effects of droughts while increasing crop productivity (Niggli, et al., 2009). Water-holding capacity of the soil is enhanced by practices that build organic matter, helping farmers withstand droughts (Borron, 2006). So if farmers perceive the conservation of soils as an adaptive strategy, this could aid not only in the protection of the integrity of the soil but also in the protection of crops from drying as well as improving on their yields.

The Democratic Republic of Congo

As the case with Nigeria and Cameroon, there is neither explicit policy nor practices branded as CSA in the Democratic Republic of Congo (DRC). Farmers in the DRC however engage in a number of practices which aim at increasing production/productivity, adaptations to changing climate scenarios, mitigating adverse effects of high carbon emission. These practices include the following:

a) **Soil and water conservation structures/ investments:** There a number of fixed investments in structures for soil and water conservation. Support of small-scale irrigation has helped to increase development of irrigation in DRC. For farmers in DRC, small-scale irrigation provide benefits by reducing water erosion, improving water quality, and promoting the formation of natural terraces over time, all of which leads to higher and less variable yields. Such structures also often provide benefits to neighbours and downstream water users by mitigating flooding, enhancing biodiversity, and reducing sedimentation of waterways (Blanco and Lal, 2008). Other structures include contour bunds – built of either earth or stone – to reduce runoff velocity and soil loss. Blanco and Lal (2008) noted that such bunds are appropriate for permeable soils on gentle to moderately sloping lands, may form the basis for terraces on steeply sloped land, and may reduce further gully erosion when built above and across gullies.

b) **Sustainable Land Management Practice:** Globally, land use change has been contributing a large share of greenhouse gas emissions. It is estimated that deforestation and other forms of land use changes contributed 17% of global carbon emissions in 2004 (World Bank, 2009). The deforestation rate in DRC is very high. Many farmers in DRC adopted a range of SLWM management practices required for adaptation to climate change before climate change became a major problem.Integrated land and water management practices have been shown to be essential to effective adaptation to climate change (Pandey, Gupta, and Anderson, 2003; Bationo and Buerkert, 2001). Among land management practices, those that increase soil carbon also enhance moisture-holding capacity, improve biological activity, and provide other benefits (Lal, 2004), thereby reducing climate-induced production risks. For example, a study in semiarid areas in Kenya showed that mulching could increase the length of the growing period from 110 to 113 days (Cooper, *et al*., 2013). Empirical evidence has also shown synergistic relationships among SLWM practices. Holding all else constant, a household that uses more than one SLWM is likely to have better adaptation than a household using only one SLWM practice. For example, Bationo and Buerkert (2001) observed that water and nutrient management increased water use efficiency and yield response to fertilizer when land and water management were combined. In a long-term soil fertility experiment in Kenya, Nandwa and Bekunda (1998) observed that plots receiving crop residues, fertilizer, and manure registered higher maize yield many years after the start of the experiment than did plots receiving the recommended or higher fertilizer doses.

c) Tree Planting and Protection, and Agroforestry: Agroforestry is prominently practised in DRC by farmers because of the large hectarage of forests in DRC, the country records one of the highest potential zones for REDD+. Protection and planting of trees was done to address the fuelwood shortage, as windbreak, and for animal browsing needs. The severe deforestation and tree cutting observed by farmers had created shortages of fuelwood and other forest products that prompted communities to plant trees.

d) Early-Maturing Varieties: Planting early-maturing varieties is an important coping strategy to climate change by farmers in DRC. Improved crop varieties provide one of the key technologies for addressing climate change. Adoption of early maturing or drought resistant crop varieties also enhances adaptation to climate change and promotes climate-smart agriculture. Temperature–tolerant crop varieties have been developed and in use. Likewise, crop varieties that resist climate-induced pests and diseases will also enhance adaptation to climate change. Agronomic management practices such as changing the time of planting to reflect the new climatic patterns and other improved technologies will generally enhance adaptation to climate change.

e) Mulching: Mulching has been identified as one of the important sustainable land management practices for adaptation to climate change. Farmers in all the ecozones of DRC practice mulching. Mulching has the ability to reduce soil temperature, and enhance carbon sequestration. Also, it can increase the length of growing season.

f) **Fertilizer and Manure Application:** Farming communities in DRC have increased their use of organic and inorganic fertilizers. A combination of organic and inorganic soil fertility management practices enhances adaptation to climate change and increases crop productivity. Hence the climate change–smart land management practices for crop production are those that integrate land and water, enhance soil carbon, and use varieties adapted in the dry areas to address climatic changes.

g) **Livelihood Diversification and New Crops:** Some livestock farmers in DRC have been diversifying their livelihoods by planting crops. New crops have been introduced in all DRC among predominantly crop farmers.

h) **Changing of Planting Date:** Changing planting date was a common strategy among farming communities experiencing a change in the onset of rainfall in DRC. Change of planting date has been an important adaptation strategy, adopted to address the perception of late onset of rainfall.

5. Policies and Actions to Promote Climate Smart Agriculture

5.1 Nigeria

Policy

A review of literature and policies across Nigeria showed that there are few national policies specifically aimed at adoption of climate smart agricultural technologies. However, most of the national policies have elements that support climate smart agriculture. The key to developing appropriate policies, strategies and actions to enhance CSA adoption is to understand the barriers to adoption of CSA practices, including the trade-offs between short-term costs and longer-term benefits, the mix of private and public benefits, institutional and financial barriers and lack of access to inputs or markets (FAO, 2012).

Some of the national policies in Nigeria that support Climate Smart Agriculture are:

- **National Adaptation Strategy and Plan of Action on Climate Change in Nigeria (NASPA-CCN).** The Federal Government of Nigeria and civil society organizations led by the Nigerian Environmental Study Action Team (NEST) developed the National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN). The NASPA-CCN seeks to minimize risks, improve local and national adaptive capacity and resilience, leverage new opportunities, and facilitate collaboration with the global community, all with a view to reducing Nigeria's vulnerability to the negative impacts of climate change. The adaptation strategy is characterized by certain imperatives based on knowledge and research, incorporation of local knowledge, gender mainstreaming and integration into national agenda so as to command wide acceptance and ensure production of the desired results (Rhodes, *et. al*., 2014). However the NASPA-CCN does not specifically mention CSA.

- **National Agricultural Resilience Framework (NARF).** To assure food and nutritional security, eradicate rural poverty and create social stability, policies and institutions are needed to enhance the ability of individuals and households to recover from impact of shocks and stresses on the Agriculture sector induced by the changing climate. The National Agricultural Resilience Framework (NARF) responds to such needs. It offers a well-articulated national policy on short and long term strategies to reduce food and nutrition vulnerability while enhancing environmental resilience. Certain aspects of the NARF that relate to CSA are;
    - o Policy framework for building capacity in the extension services that would assist farmers in achieving change in agricultural practices for CSA.
    - o Expansion of Irrigation agriculture in water deficit AEZs and best practice water management for

the whole country.

- o Policy that create enabling environment for funds accessibility and at low interest rates that would drive the change in practices for CSA.
- o Economic Incentives and transitional programmes will be required in the short term in order to achieve long-term benefit of change in agricultural practices.

Others policies in Nigeria related to climate change include the following;

- **Agricultural Transformation Agenda (ATA)**

- **National Policy on Environment:** The goal of the policy is to achieve sustainable development in Nigeria and, in particular to
  - (i) secure a quality of environment adequate for good health and well-being;
  - (ii) promote the sustainable use of natural resources;
  - (iii) restore and maintain the ecosystem and ecological processes and preserve biodiversity;
  - (iv) raise public awareness and promote understanding of linkages between environment and development; and
  - (v) cooperate with government bodies and other countries and international organizations on environmental matters.

Nigeria has also enacted a number of specific policies and action plans for the implementation of the National Environment Policy. These policies that could be adapted to support national climate change mitigation and adaptation response efforts include:

- **National Policy on Drought and Desertification:** The National Policy on Drought and Desertification, recognizes that climate change could intensify drought and desertification in the part of the country that are very prone to these environmental problems. Thus the policy emphasized the need to equip relevant agencies, institutions and citizens adequately to collect, analyze and use climate data effectively to ameliorate and combat drought and desertification.

- **Drought Preparedness Plan**.

- **National Policy on Erosion, Flood Control and Coastal Zone Management.**

- **National Forest Policy**: The National Forest Policy is geared towards ensuring sustainable forest management, promoting participatory process of development, facilitating private sector – forestry development and adopting an integrated approach to forestry development. Government is currently embarking on a number of afforestation programmes. Under the guidance of the African Union Commission, Nigeria is keying into the project on the "Green Wall Initiative" in which a "green wall" of trees (40 million trees annually in the next 10 years) will be planted across the dry-land area of Nigeria to not only push back deforestation and secure agriculture and livelihoods across the Sudan-Sahelian zone of the country, but also enhance the carbon sequestration of biological diversity resources in the region for climate change mitigation.

- **National Biodiversity Strategy and Action Plan**. The goal of the National

Biodiversity Strategy and Action Plan is to develop appropriate framework and programme instruments for the conservation of Nigeria's biological diversity and enhance its sustainable use by integrating biodiversity considerations into national planning, policy and decision-making processes. It provides frameworks for addressing

(i) biodiversity conservation,
(ii) sustainable use of biological resources,
(iii) equitable sharing of benefits,
(iv) conservation of agro-biodiversity, biosafety, and
(vi) biodiversity-industry interface.

Programs and projects active in Nigeria

There are several national programmes and projects going on in Nigeria. These are either implemented by government agencies or non state actors. Some of these programmes include: National Programme for Food Security; National Agricultural Policy on Water Resources Development and Irrigation Policy; National Agricultural Policy on Pest and Disease Control; National Agricultural Policy on livestock production, National Agricultural Policy on Agricultural Research; National Agricultural Policy on Agricultural Extension; National Biodiversity Protection Policy; and the National Policy on Integrated Rural Development.

5.2 Cameroon

Policy

There is no explicit policy dealing with CSA in Cameroon. However, in relation to climate change, Cameroon submitted its First National Communication in 2005, under the direction of the Ministry of Environment and Forests. This document is summarized in Table 4.5. The Government of Cameroon aims to establish a country-wide approach to adaptation that would particularly test adaptation measures in the different eco-zones, taking a poverty reduction focus and integrating gender-sensitive approaches. The government has also established a body called the Cellule *Nationale des Changements Chmatiques*, which is mandated to:

- Create an inventory of national greenhouse gas emissions and adaptation measures,
- Put into place an information system and database on climate change, and to establish an online home for information to ensure accessibility and dissemination;
- Design sectorial projects addressing priority actions for climate change prevention, mitigation and adaptation; and,
- Evaluate the impacts and policies associated with adaptation and mitigation (CMEF, 2005).

Climate change adaptation and mitigation considerations have also been integrated into the country's National Plan for Environmental Management (Plan National de Gestion de 1'Environnement, PNGE). With Cameroon's high vulnerability to sea level rise, coastal adaptation strategy will be included under the plan (CMEF, 2005).

Programs and projects active in Cameroon

There are some programmes and projects active in Cameroon. These are summarised in Table 4.6. Cameroon was one of eight countries that received funding in the Africa Adapt Knowledge Sharing Innovation Fund in 2009. Among others, this nationally focused project, addresses:

- Review of Current and Planned Adaptation Action: Middle Africa implemented a small project to increase awareness and improve the capacities of the country's Pygmie communities to adapt to climate change (AfricaAdapt, 2009).

- On a regional level, Cameroon is participating in the program, "Supporting Integrated and Comprehensive Approaches to Climate Change Adaptation in Africa," or Africa Adaptation Programme, a multi-national, US$92 million initiative launched in 20 African countries by the Japan International Cooperation Agency in 2008. In Cameroon, a US$3 million project is being implemented with the goal of ensuring that the country has the institutional, individual and systemic capacity to address climate change risks and opportunities through a national approach to adaptation (UNDP, 2010).

- Cameroon is also participating in the Climate Change Adaptation in Africa (CCAA) program, co-financed by the International Development Research Centre (IDRC) and the UK Department for International Development (DFID). Their project, "Altering the Climate of Poverty under Climate Change: The forests to the Congo Basin," aims to underscore the importance of the Congo Basin forests in climate change adaptation efforts. This research and policy-formation project is also being implemented in neighbouring Central African Republic and the Democratic Republic of Congo, and will rely on community participation and perspectives in all three countries to develop appropriate forest management strategies. It is being implemented by the Center for International Forestry Research (CIFOR), and is part of their larger global program on enhancing the role of forests in climate change adaptation (IDRC, 2008).

- Under the same regional CCAA program, Cameroon is participating in the regional project "Advancing Capacity to Support Climate Change Adaptation." The aim of the project is to reduce the vulnerability of poor populations in sub-Saharan countries to climate change by mobilizing scientists and other stakeholders to inform political decision-making. In Cameroon, the project will emphasize the "generation, organization and communication of information on the risks resulting from climate change, climate variability and extreme climatic events, as well as preparation for their effects on food security" (IDRC, 2007).

- Cameroon is involved in a global Worldwide Fund for Nature (WWF, n.d.) project examining its approach to building resilience to climate change in tropical mangroves and associated coral reefs. The vulnerability assessment and capacity building project is also being implemented in Tanzania, Fiji and India, though specific activities being carried out in each country are unknown.

- Between 2007 and 2009, Helio

International implemented a research project on climate-proofing energy systems in a number of African countries, including Cameroon and DR Congo. The objective of the project was to develop a methodology and indicators for assessing the vulnerability of energy systems to climate change, and to adapt these systems to climate change (Helio International, 2009).

- As part of the Lake Chad watershed, Cameroon is also participating in the six-year "Lake Chad Sustainable Development Support Program," a five-country, US$95 million effort to promote sustainable development in the Lake Chad Basin and reverse. One of the project's specific objectives is to improve the adaptive capacity of the lake's productive systems to climate change. The extent of activities being undertaken in Cameroon under the project is unclear (AfDB, 2009).

- As a member of the Central African Forests Commission (COMIFAC), Cameroon will also benefit from COMIFAC's current project on climate change scenarios for the Congo Basin. It is hoped that these scenarios will enable decision makers in the country and throughout the COMIFAC region to adapt and prepare their natural resource management strategies to meet the regional challenges of climate change (BMU, 2010).

Table 5.1 Key Cameroonian Policies and reports on needs, priorities and planned actions

	Government Division Responsible	Status	Sector(s) of Focus	Summary description
National Plan for Environmental Management	Ministry of Environment and Forests	Adopted in 1996	Multi-sectorial	The objective of this national plan is to ensure national environment and the sustainable use of natural resources. Climate change mitigation and adaptation strategies are included in the national plan in the areas of: reducing greenhouse gas emissions through the preservation of forests; coastal zone management; and the promotion of alternative energy sources. Greenhouse gas emissions are considered a form of air pollution in the plan.
Communication nationale initiale du Cameroun sur les changements climatiques (Cameroon's Initial National Communication on Climate Change)	Ministry of Environment and Forests	Submitted in January 2005	Agriculture, Forests, Energy, Waste management, Coasts	This document presents an inventory of greenhouse gas emissions in Cameroon, identifies the negative impacts that climate change might have on vulnerable populations and ecosystems in the country, and lists the necessary measures that must be undertaken to respond to these challenges.

Table 5.2 Current adaptation projects and programmes active in Cameroon

	Objectives	Funder(s)	Implementing Agency(s)	Type of Project	Duration	Priority Sector(s)	Geographic focus (if any)
The Pygmies of Eastern Cameroon face Climate Change (Les Pygme'es de l'Est du Carneroun face aux changements climatiques)	This project aims to increase awareness and improve Pygmies' capacity to adapt to Climate change. More specifically, it will survey Pygmy perceptions on climate change, provide them with a forum for identifying the major climatic changes affecting their lives and identifying adaptation options. Through these processes they will be able to articulate their expectations around the actions need to strengthen their resilience.	Africa Adapt	Association for the Promotion of the Environment and Sustainable Development	Knowledge Communication Community based adaptation	2009-2010	Civil society	Eastern Cameroon

	Objectives	Funder(s)	Implementing Agency(s)	Type of Project	Duration	Priority Sector(s)	Geographic focus (if any)
Developing a method for Adaptive Management and Protection from Climate Change in Mangrove and Coral Reef Ecosystems	This project sought to develop a generalised approach for assessing vulnerability and adaptation of mangroves and associated ecosystems in high biodiversity tropical mangrove areas and associated coral reef, sea-grass and upland ecosystems.	GEF/UNEP; WWF; Partner Organizations	WWF, Wetlands International, Institute of Applied Sciences, Wildlife Conservation Society, Communities	Capacity building	2007 - 2009	Coastal zone management; Ecosystem conservation	Global.- Cameroon, Fiji, Tanzania
Climate Proofing Energy Systems: Vulnerability-Adaptation-Resilience	The objective is to develop a methodology and indicators in order to evaluate the vulnerability of energy systems to climate change and to adapt to climate change	France; GIZ; BMZ; IUCN; La Francophonie	Helio International	Research; Assessment	2007 – 2009	Energy	African: Benin, Burkina Faso, Cameroon, DRC, Kenya, Nigeria, Senegal, Tanzania, Uganda

	Objectives	Funder(s)	Implementing Agency(s)	Type of Project	Duration	Priority Sector(s)	Geographic focus (if any)
Advancing Capacity for Climate Change Adaptation (ACCCA)	The rational for this project is that countries lack scientific knowledge and understanding of climate risks, and that this is an impediment to addressing climate variability. Activities include the following: identify and prioritize climate risks; assess available knowledge about risks and adaptation opportunities; develop, test, and	IDRC;DEFRA; Swiss Federal Office for the Environment NCAP; European Commission	UNITAR	Assessment; Capacity building; Policy formation and integration	2007- 2010	Multi-sectoral	Global 17 countries in Asia and Africa including Mali, Niger and Nigeria

	Objectives	Funder(s)	Implementing Agency(s)	Type of Project	Duration	Priority Sector(s)	Geographic focus (if any)
Interdisciplinary and Participative Research on Interactions between Ecosystems, Climate and Societies in West Africa	The project will identify the relations between ecosystem vulnerabilities and human populations in order to scientifically support political responses to climate change.	France Foreign Affairs Ministry	Agence inter etablissernents de la recherche pour le developpernent (Inter-institutional Research Agency for Development)	Research	2007 -2011	Ecosystem conservation	Regional: Benin, Burkina Faso, Cameroon, Cape Verde, CAR, Chad, Cote d'lvoire, Gambia, Ghana, Guinea, Guinea Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Togo
Altering the Climate of Poverty under Climate Change: The forests of Congo Basin	This project aims to underscore the importance of the Congo basin forests in climate change adaptation efforts in Cameroon, Central African Republic and the Democratic Republic of Congo. Researchers will map adaptation priorities and policies	DFIO through IDRC's CCAA Program	Center for International Forestry Research (CIFOR)	Research; Community-Based adaptation; Policy formation	2008 - 2011	Forestry	Regional: Cameroon, CAR, DRC

5.3 Democratic Republic of Congo

Policy

There is no policy dedicated to CSA in the DRC. However there are some policies and documents dealing with climate change, agriculture and related issues. These include:

- **National Communication**

Under the United Nations Framework Convention on Climate Change (UNFCCC), DRC submitted its First National Communication in 2000 and its Second National Communication in 2009 (Crawford, et *al*., 2011). In between, the country prepared its National Adaptation Programme of Action (NAPA), which was released in 2006. The First National Communication to the UNFCCC document describes the action taken by the DRC on climate change mitigation and adaptation (Crawford, et *al*., 2011). It provides an overview of the country's context, followed by an inventory of domestic greenhouse gas emissions. The report describes various climate change scenarios expected for the country, along with vulnerabilities in three priority areas: water resources, agriculture and coastal zones. Strategies are then presented that can help to strengthen adaptive capacity and reduce vulnerability.
The DRC's Second National Communication updates the information and strategies contained in its First National Communication. In the interim period, the context changed considerably due to violent conflict, which has increased poverty and compromised health systems, among other impacts. The Second National Communication provides updated figures on national greenhouse gas emissions, climate change vulnerability and adaptation requirements, with a sectoral focus on water, coasts, health, forests and agriculture (Crawford, et *al*., 2011). It concludes by providing technological requirements, climate observation capacities, environmental management capacities and public awareness on climate change. These documents remain the main government policy initiatives on climate change adaptation; consideration of the impacts of climate change has not yet been integrated into other policy initiatives (Crawford et al., 2011). For example, no explicit mention of climate change adaptation is made in the country's most recent Poverty Reduction Strategy Paper (completed in 2007), although implementation of the UNFCCC is mentioned under the "Environment" pillar (Crawford, et *al*., 2011). However, the DRC is in the process of formulating—in conjunction with the Food and Agriculture Organization (FAO)—a National Programme for Food Security (Programme National pour la Sécurité Alimentaire) (Crawford, et al., 2011). The goal of this program is to increase production and productivity of the agricultural sector to ensure national food security, thereby at least partially addressing one key area of vulnerability, as identified by the country's Second National Communication.

Under the UNFCCC DRC is committed to finding ways and means to mitigate climate change. Thus it has:

- Signed the Framework UN Convention on Climate Change in June 1992 at the Earth Summit on Environment and Development held in Rio de Janeiro;
- Ratified the Convention 8 December 1994;
- Continues to take part in international meetings on this subject, particularly the Conference of the Parties;
- Contributions paid despite its many difficulties;
- Ratified several international conventions and agreements on the

environment.

Since then, the country made an effort to meet its commitments, and take part in various layers related to the organization and operation of these agreements (COPs, secretaries' sessions, informal meetings, and negotiations). Similarly, the DRC is taking steps in order to benefit from technology transfer provided in most of these agreements in favor of least developed countries.

- **National Adaptation Programme of Action (NAPA)**

The most important document dealing with climate change in the DRC is the NAPA. NAPAs were intended for Least Developed Countries to identify activities that respond to their urgent and immediate needs to adapt to climate change. Crawford, et *al*., (2011) reviewed the NAPA of DRC and found that the CSA factors considered in their analysis were: Freshwater Resources; Agriculture; and Coastal zone management. The DRC NAPA comprehensively outlines proposed adaptation strategies which are related to Climate Smart for the various sectors as follows:

i. **Freshwater Resources:** Evaluation and monitoring of water resources, particularly those of the Congo River system and its Kinshasa-area tributaries, and the quality and quantity of both surface and groundwater. Impact of the system on the quantity and quality of groundwater for enhanced resource allocation planning. Characterization and development of the watersheds identified in Kinshasa for control of the surface run-off. Protection of water resources against pollution. Support of adaptation infrastructure capable of handling the projected hydrological variations, and improved understanding of the economic, social, and ecological costs of the adopted measures. Establishment of communities on the Kinshasa hill areas and on the Batéké Plateau in order to protect them from the negative effects of increased flooding.

ii. **Agriculture:** Improved zoning for land use, reforestation programs in deforested areas, soil improvement programs, strengthened pricing systems and distribution chains for agricultural producers, orientation towards economic activities with reduced impacts on the forests, community-based management of forest ecosystems, agricultural extension services, yeld-improvement research. Improving local knowledge for stronger ecosystem conservation, infrastructure rehabilitation.

iii. **Coastal zone management:** Regulation of mangrove development. Coastal area development policy. Delineation of building and residential areas. Diversification of activities for farmers and fishers.

- **Agriculture policy:** The government's objective in this sector is to restore a level of agricultural production to meet the nutritional needs of the entire population, and restore the bases of social cohesion so as to ensure sustainable peace and stability in the country. To this end, the government undertook institutional reforms of the Ministry of Agriculture and conducted a preliminary institutional assessment; and developed a proposal for restructuring the Ministry of Rural Development; and adopted a harmonized strategy for the agriculture and rural development sector.

To support agricultural production, improved seeds were distributed and rural producers were provided with training; these actions served to improve crop production and stabilize prices. The physical achievements during implementation of the PRSP include:

(i) 10,317 kilometers of rural roads rehabilitated and 7,500 kilometers of rural roads being maintained with financing from the Kingdom of Belgium;
(ii) 120 kilometers of rivers and streams improved;
(iii) buoys installed in 40 kilometers of waterways with government financing;
(iv) three National Seed Service (SENASEM) laboratories rehabilitated;
(v) 32 sources of drinking water provided;
(vi) four animal containment areas with paddocks and water troughs; and
(vii) 94 markets and storage facilities are being constructed with financing from the African Development Bank in the provinces of Katanga, East Kasai, West Kasai, Bandundo, and Bas-Congo (Luhembwe, 2014).

According to Luhembwe (2014), 702 tractors and 30 cultivators were acquired and sent to all provinces and selected National Institute for Agronomy Research (INERA) stations. He also noted that the purchase of 85 pairs of draught animals and training of 125 pair of cows and 410 pair offarm animals were made. These actions served to maintain the agriculture and rural development sector share in GDP at roughly 3 percent (Luhembwe, 2014).

Despite the above outcomes, the agriculture and rural development sector continues to face significant challenges in terms of access to markets and credit, particularly for investments; access to technology and quality plant products; access to land and land management; and labor availability and productivity.

• **Environmental policies:** The government's policy in regard to forests is to rehabilitate the sector and promote sustainable management of flora and fauna to increase their contribution to the economic, social, and cultural development of present and future generations.

To this end according to Luhembwe (2014), the Government of the DRC established the following objectives:

(i) combat desertification through sustainable management of lands and forests,
(ii) promote awareness of forest laws;
(iii) reduce emissions due to deforestation and degradation,
(iv) improve the forest management information system,
(v) strengthen the capacities of the ministry and its agencies, and
(vi) administer a national action plan to adapt to climate change.

The government of the DRC finalized most (some 30 of 42) of the implementing regulations under the forest code in 2009 (Luhembwe, 2014). At the same time, it strengthened commercial services and support to the Sustainable Land and Forest Management Board by establishing a national committee on forest and land degradation.

• **Water policies:** According to Luhembwe (2014), the water and sanitation sector in the DRC is now in the midst of fundamental reforms initiated by the new Constitution (2006), the laws for the reform of public enterprises and the disengagement of the state (2007), and the Decentralization Law (2008), which has moved responsibilities away from the central government. A comprehensive new

Water Law has been in development since 2007 and its final draft was accepted in a broad stakeholder review in September 2010 (Luhembwe, 2014). Basic targets for the water and sanitation sector have been formulated in the DSCRP (2006), and two successive Priority Action Programs (PAP I &II) have undertaken first steps to attain these (Luhembwe, 2014). Going forward, the key reform objective will be to pass the proposed Water Law and then translate the new framework into reality by developing a clear sector policy and streamlining the institutional structure accordingly, as well as reinforcing capacity (Luhembwe, 2014). So far, reform efforts have been focused on the national water utility REGIDESO, which is responsible for urban water supply and a natural target of reform efforts given its central importance in urban areas and its remaining capacity. The government has launched a comprehensive operational and financial reform program *(Programme de Redressement Opérationnel & Financier)* combining reform, commercialization, upgrading of management, and investments.

• **National Agricultural Investment Plan (PNIA):** Under Africa Union's New Partnership for Africa's Development (NEPAD) and with COMESA support, the Government of the Democratic Republic of Congo (GDRC) initialized the CAADP process in 2009, signing the compact in March 2011 in the presence of key stakeholders, including farmers' organizations, private sector firms and chambers of commerce, international donors and representatives of regional economic communities of which DRC is a member. The next step in the process was to develop a National Agricultural Investment Plan (PNIA), obtain national level validation (following critical reviews from NEPAD and FAO) from stakeholders and organized an official launch event, or 'business meeting', which occurred in Kinshasa on Nov. 7-8, 2013 (Africa Lead Team, 2014). Publicly, inaugurating the PNIA served to announce the level of financial commitments from GDRC, the private sector and international donors, identify priority funding gaps to fill, and obtain expressions of interest from private investors. A total of $5,730 million is budgeted for the PNIA, with only $857 million currently committed (93% from donors, 7% from GDRC) (Africa Lead Team, 2014). There is no dedicated, independent M&E entity responsible for tracking activities and measuring impact or growth.

In this regard, GDRC is demonstrating some political support for the CAADP process and making limited progress against its commitments. The CAADP process and the resulting PNIA, while results remain to be seen, have been salutary for the GDRC by making more explicit actions needed to address the country's famously poor business climate. Concrete improvements are slow to materialize, and many vested interests remain, but domestic awareness of this problem is now high among Congolese. The PNIA requires internal and external coherence with extant agricultural and food security policies of the DRC and the regional bodies to which it is beholden. Internally, these policies are the Note de *Politique Agricole* (2009) and the *Stratégie Sectorielle de l'Agriculture et Développement Rural* (SSADR, 2010); regionally these are the CAADP itself, the *Document de Stratégie de la Croissance et de la Reduction de la Pauvreté* (DSCRP, Congo's Poverty Reduction Strategy Paper) and the Millennium Development Goals (Africa Lead Team, 2014). Again, while the results of this coherence are yet intangible, the process itself has helped reduce the country's political and economic isolation in the region.

In interviews and public pronouncements, government officials are confident that their chosen path, the PNIA, is compliant with CAADP principles, objectives and metrics. While its conditions for success are indeed challenging, officials claim that it will modernize and monetize Congo's vast agricultural potential, transforming the lives of the country's rural poor, nearly all of whom are isolated, subsistence farmers. Overseeing the operation of the PNIA are three high-level committees, the *Comité de Pilotage, the Comité Technique and the Comités Provinciaux de Pilotage*. The two former are centrally located; the latter exists at the provincial level. Finally, the PNIA consists of five sub-programs:

- Promotion of Agricultural Value Chains and Agribusiness
- Managing Food and Nutrition Security and Strategic Agricultural Reserves
- Agricultural research, extension and training
- Governance, gender mainstreaming and capacity building for public institutions in the sector
- Adaptation to Climate Change

In terms of specific commitments, PNIA aims are two fold. First, it seeks to increase public agricultural expenditure (PAE), with a prescribed goal of 10% by 2020, the most salient Maputo Declaration expenditure target (Africa Lead Team, 2014). In late 2012, PAE was at 2%, the lowest among its Central African neighbors; although officials maintain that in 2013 they have surpassed 3% (Africa Lead Team, 2014). Second, the PNIA will fuel growth in the agricultural sector to reach the CAADP sector growth rate target of 6% (i.e., the portion of GDP from agriculture) (Africa Lead Team, 2014). These metrics are causally linked, for at least 10% PEA is required to achieve an annual growth rate of 6% and since 2012, the GDRC has disbursed a total of $40m on agriculture, research and training, and at the current rate of public spending and without significant foreign investment, GDRC will not reach its 2020 target of 10% PAE (Africa Lead Team, 2014).

As a preparatory exercise for the PNIA and to stir a dormant history of PAE, the GDRC began in 2012 to solicit proposals for agricultural activities from provincial governments, to be funded from Kinshasa and outsourced to local actors, but managed and monitored by state provincial institutions. The first year (2012-2013) of this initiative, the *Campagne Agricole*, saw the disbursement of $20m across eleven provinces (Africa Lead Team, 2014). The money was transferred to provincial governments, who commissioned local implementers (private service providers and farmer organizations) to execute the activities. Provincial government was tasked with oversight and impact analysis. Only five provinces have subsequently reported on their activities and accounted for monies received. For the 2013-2014 campaign, GDRC committed $80m, but has only disbursed $20m so far, pending reporting from the previous season (Africa Lead Team, 2014).

These initial investments from central government are evidence of 'political will' towards a more robust agricultural sector, yet it is widely believed that central government, line ministries or the provincial institutions do not possess the technical capacity or resources to disburse or track this funding effectively and transparently, nor are they able to measure its impact against any baseline, as none was taken at the start of this initiative. Provincial Ministers of Agriculture and Rural Development (MINAGRIDER) met in Kinshasa during the PNIA 'business meeting' professed divergent views: some openly critical, others diplomatic and supportive

(Africa Lead Team, 2014).

Outside of government, skepticism regarding the PNIA and the government's commitment to agricultural sector growth is high. The primary criticism, heard from donors and the Congolese private sector, accuses the GDRC of failing to commit to sweeping infrastructural renovation (communications, transport, electricity, etc) as the *sine qua non* of national economic growth. Instead of shifting that burden onto the international firms others in government are lining up to invest (Africa Lead Team, 2014).

Programs and projects active in the DRC

There are some programmes and projects implemented in the DRC which have implications for CSA. These include:

PANA-ASA Project: This project supports the dissemination of the drought resistant seed varieties of some crops such as maize, beans and soya bean to enhance the household's likelihood of achieving better yields, and food security. This practice is not traditional but it is driven by the Government, with the support of its partners. This project involves collaboration between the National Institute of Agricultural Research (INERA) and the Ministry of Agriculture, Universities, UN Agencies such as FAO, local and international NGOs and community based organizations of small farmers, especially in the region around the city of Lubumbashi (Luhembwe, 2014). Since 2010, PANA-ASA project is implemented in four sites within four provinces of the DRC (Eastern Kasaï, Bandundu, Lower Congo and Katanga) where INERA plays the role of research partner in collaboration with IITA (International Institution of Tropical Agriculture). The project works on three fronts which are the following:

(i) Ensuring climate resilience of production systems,
(ii) Strengthen the technical capacity of small producers and agricultural institutions to develop appropriate response strategies to climate change and finally,
(iii) Identify and disseminate best practices. The output of the supply chain operational resilient seeds of PANA-ASA project:
    - Access to improved germplasm and resilient staple crops has improved compared to the baseline
    - The rate of agricultural productivity in the project beneficiaries has increased and the standard of living of these significantly improved
    - Agricultural services supervisory capacity are strengthened and effectively involved in coaching and assisting beneficiaries
    - Improved techniques for management of soil, water and equipment are increasingly adopted and improved;
    - Revenues are diversified and can mitigate income of small producers

In addition to these technological practices in use, building technical capacity of small producers and agricultural institutions is being pursued through conducting training courses for trainers in the areas of climate change, agro-ecology, seed production and water management (Luhembwe, 2014). The aim is to bring the acquired knowledge to the level of farmers that are vulnerable households in the villages, in a simple and comprehensive way.

Agroforestry project around the city of Lubumbashi in DRC: Through this project, the mitigation aspect is taken into account as such the program allows people to achieve food security within a less climate harmful framework. This project is being implemented by GRET (Groupe de Recherche et EchangeTechnologique). As in the first case, this project is supporting farmers within a community based organization. The targeted aim is to end up with a regenerated Miombo forest while achieving food security increasing needs and the wealth of the farmer's households within a region that has been highly anthropized.

Climate resilience of production systems: To date, the project has set up a chain of resilient seed production for five crops (maize, rice, cowpea, groundnut, beans) from basic seed made available by INERA and supplied to agri-multipliers. For this first production, a hundred tons of seeds (all crops combined) are expected to be made available to farmers. Screening trials of resilient varieties, led by INERA in collaboration with IITA, are installed through the four INERA stations participating to the project.

Improved sorghum cultivars for the semi-arid lands: Sorghum (*Sorghum bicolor* L. Moench) is one of the most resilient crop species in terms of resisting drought and even floods. Sorghum was ranked number two by the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) among the major cereal crops in terms of resilience, as nutrition, and opportunity to enter the commercial markets. The average yield potential for sorghum has remained stagnant at between 0.5 to 2.5 tons per hectare in the area (Kimenye, 2014). Sorghum yields can be improved by enhancing the productivity potential, as well as improving the crop's adaptation and resilience to cope with adverse growing conditions caused by climate change. At least more than 50 sorghum varieties have been released across 10 ECA countries since 2010. Some of the varieties have multi-country release status.

Congo Forest Basin Project: Provides multiple benefits, practices that increase productivity, carbon sequestration, rehabilitate degraded lands and build resilience. The Congo Basin Forest Fund (CBFF) was launched in June 2008. It is coordinated by the African Development Bank in DRC and other 9 Central African countries and aims to address climate change across the Congo Basin. This is achieved primarily by reducing deforestation, forest degradation and poverty through better land use planning; developing sustainable management mechanisms for the natural forests of the region; stabilizing the agricultural sector; and promoting local development. The project takes two concurrent approaches: a bottom-up approach supports NGOs to assist local communities to implement sustainable forest management, while a top down approach helps government projects design strategies and frameworks to reduce and monitor greenhouse gas emissions from deforestation and forest degradation (REDD+) (Nyasimiet al., 2014). The CBFF has worked with 85 communities encompassing 14193 direct beneficiaries who have been engaged in producing 57 geo-reference community maps used to influence policy decisions; and in addition, the beneficiaries are now aware of their rights, especially in terms of access and control of forest and land resources, as well as their role and involvement in natural resource management (Nyasimi, et al., 2014). Among the beneficiaries, 90% relied on woodfuel from the forest as the primary source of domestic energy; and with the introduction of agroforestry practices, communities reduced harvesting trees from the forests (Nyasimi, et al., 2014). In addition, the project also encouraged the use of energy saving stoves and kilns; the project distributed 380 improved stoves and kilns; more than 60% of women within the project adopted the technology; and about 1330 women were trained in new fish smoking techniques using less wood energy, leading to a 44% decrease in wood consumption (Nyasimi, et al., 2014).

Catholic Relief Services (CRS) No-Till-Agriculture pilot project in DRC: No-till agriculture substitutes the short-term benefit of using forest ash as fertilizer with the sustainable fertility of decomposing organic material, renewed by the farmers' own crops. This protects the soil and its organic matter from the harsh rays of the sun and tropical rainstorms, which cause extensive erosion on hillsides. The process also suppresses weeds. Manual tillage is replaced by the soil-nourishing activity of earthworms, beneficial insects and bacteria. No-till agriculture not only protects forests, the principal asset of the farmer, but also the soil. After 2½ years of experimentation, farmers living in the rainforest zones have already converted half of their land to the new conservation techniques. CRS is teaching more than 8,000 farmers in DRC how to use no-till methods to avoid traditional slash-and-burn practices that destroy the rainforest, deplete the soil and produce less.

6. Existing Gaps and Investment Opportunities

6.1 The CAADP CSA Framework

Nigeria, Cameroun and the DRC have signed on to the CAADP. In identifying gaps and investment opportunities for CSA within the CAADP framework, we have to first isolate issues in the framework that are relevant to CSA. Assisting African countries raise agricultural productivity by at least 6% per year is the first pillar relevant to CSA. CAADP seeks to achieve this through managing its second aim which is for African countries to increase public investment in agriculture to 10% of their budgets. All three countries have not been able to achieve sustainable 6% increase in productivity annually. Also all three countries have not been able to allocate at least 10% of National budget to agriculture. The framework provides guidance to national and regional initiatives on programmatic approaches on knowledge generation, knowledge management and technology transfer and financing up scaling, based on adaptation and mitigation measures, including sustainable land and agricultural water management. This is also relevant to CSA.

CAADP contributes to agricultural development in Africa at two levels as follows:

Level 1: Agriculture's Contribution to economic growth and inclusive development.

At this first level, CAADP provides an opportunity for implementing CSA for communities to reap benefits through: Carbon funds and public-private partnerships and create wealth, (ii), improve nutrition through increased productivity and climate change adaptation mitigation. Through these levels, all the six spheres (Figure 6.1) of the CAADP CSA framework are addressed. While increasing agricultural production and productivity is the fundamental goal, the initiatives should in one way or another address adaptation and mitigation, hence Climate Smart Agriculture.

Level 2: Agricultural Transformation and Sustained agriculture growth where four result areas are identified as:

i) Increased agricultural production and productivity;
ii) Better functioning national agriculture and food markets and increased intra/ inter-regional trade;
iii) Expanded local agro-industry and value addition;
iv) Improved management and governance of natural resources for sustainable agricultural production. These also offer opportunities for CSA.

The Comprehensive Africa Agriculture Development Program (CAADP) is the key arena for ensuring that climate change is mainstreamed into agricultural development (Fig 6.1). It provides an opportunity for incorporating Climate Smart Agriculture into Country and Regional Programmes through the development of the National Agricultural Investment Plans (NAIPs) or National Agricultural Food Security and Investment Plans (NAFSIPs). These plans are the key instruments for rolling out the CAADP process (Loada, 2014).

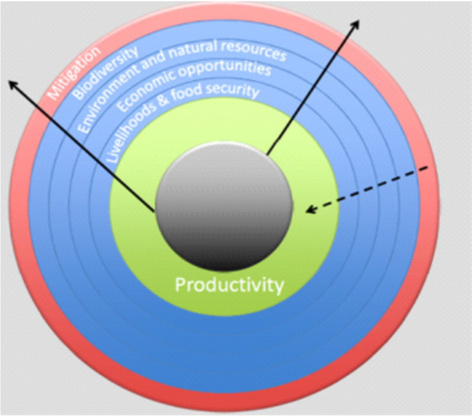


Figure 6.1 The six spheres of CSA for increasing productivity, resilience, and mitigation

Source: AU-MNote: The focus starts from the inner circle with the highest importance.

A synthesis of the existing gaps and investment opportunities where CSA can intervene within the CAADP framework are articulated under three broad themes of research, technology, and policy. These are summarised in Table 6.1 and include the following:

6.2 Gaps in Technology

Information tools and approaches that allow for characterization and mapping of the agricultural, forests, and pastoral implications of long-term climate change and the development of climate risk management strategies specifically tailored to stakeholders needs are lacking. Therefore there is the need to develop these area for shareholders. National policies need to devise, promote and support strategies for out-scaling proven technologies in regions across the country (FANPRAN, 2013).

CSA can be practiced at the plot, farm and landscape levels (CAADP, 2010). Most of the adaptation/mitigation options reported for crops and livestock seem to be neglected even though the NAPAs and National Communications to UNFCCC show that livestock is a major contributor to GHG emission.

6.3 Gaps in research

There are gaps in Scientific Capacity to Improve Adaptation-Mitigation Response. The General Circulation Models (GSMs) commonly in use were developed outside Africa. While there is substantial capacity at the CGIAR centres, there is inadequate national capacity on modelling of climate scenarios and impacts on annual crops, tree crops and integrated pest management and livestock. Climate change scenarios for the three countries based on GHG emissions and contributions of agricultural activities to warming remain highly uncertain. Productivity growth research in relation to climate change is needed. More practical research and innovation is urgently needed to identify barriers (e.g labour) to wide spread adoption of those technologies; propose ways of alleviating them; and develop appropriate approaches to guide investments that will assure improved resilience, productivity and sustainability in smallholder systems.

6.4 Gaps in Policy

Lack of a consolidated or coordinated approach to CSA and adaptation to projected climate impacts on a local scale. National CSA dialogue to involve all stakeholders should be organized. There is little awareness about CSA in the three countries. Having a forum where all stakeholders will be present and dialogue about how Nigeria, Cameroun and the DRC should achieve CSA is however paramount. CSA needs to be integrated into mainstream national agricultural development policy and planning processes to facilitate a more holistic and system-wide approach to engaging with agricultural sector challenge and responses.

Extension services (public and non-public) need foundation training to acquire core proficiencies in CSA from management levels, through specialists, to local field personnel. Farmer training modules need to have high impact communication and training materials, using innovative and state-of-the-art ICT and media. Youth and

schools need to be actively engaged in CSA extension programme strategies to broaden dissemination, bring the next generation on board, and achieve greater impact.

Table 6.1 Gaps and investments where CSA can intervene within the CAADP framework

Gaps and investment opportunities needed for effective implementation of CSA	**What needs to be done in each of the gaps identified**
Gaps in Technology Information, tools and approaches that allow for characterization and mapping of the agricultural, forests, and pastoral implications of long-term climate change and the development of climate risk management strategies specifically tailored to stakeholders needs are lacking	Develop information, tools and approaches that allow for characterization and mapping of the agricultural , Forests, and pastoral implications of long-term climate change and the development of climate risk management strategies specifically tailored to stakeholders needs
Gaps in Policy 1. Lack of a consolidated or coordinated approach to adaptation of projected climate impacts on a local scale.	Advocate for the Implementation of NAMA and NASPA/NAPA
Gaps in research 1. climate change scenarios for DRC based on GHG warming remain highly uncertain Conduct research on climate change scenarios for DRC based on GHG warming remain highly uncertain 2. Productivity growth research in relation to climate change lacking.	*Productivity growth to be conducted* • Agricultural research and extension systems • Weed and pest control • Soil and water management • Awareness raising and consensus building on biotechnology-related opportunities and risks
Gaps in finance 1. Many factors contribute to the current low levels of investment, but production uncertainty associated with between- and within-season rainfall variability remains a fundamental constraint to many investors who often overestimate the impact of climate induced uncertainty. 2. Lack of public sector financing through national budgets	• governments need to provide budgetary support for CSA by allocating their own resources to promising initiatives • Access climate change funds
Gaps in markets 1. Lack of market intelligence	*Market improvement* • Market intelligence (domestic, regional and international) *Linkages with non-agriculture* • Storage, processing, distribution • Agro-industrialization

6.5 Gaps in Financing

Cameroun

The overall cost of NAIP thematic fields and actions for Cameroun is estimated at 3.351 CFA billions for the 2014-2020 periods, distributed fairly equitably between value chains development, modernization of the production machinery, governance and institutional development. The Government has acquired about 58% of the funds with huge gap to cover as shown in table 6.2 below.

Table 6.2 NAIP and the Financing Gap (billion CFA Francs)

Intervention Rationale	Costs	Funding	GAP	% GAP
Thematic Field 1:Developing production value chains and improving food and nutritional security	1 101.6	798.2	303.4	20.1
Thematic Field 2: Modernising rural production infrastructure and improving food access to financing	910.9	237.9	673.0	44.6
Thematic Field 3: Sustainable management and valorization of natural resources	413.8	283.9	129.9	8.6
Thematic Field 4: Governance and institutional development	1 124.8	722.1	402.7	26.7
Total of NAIP 2014-2020.	**3 551.1**	**2 042.1**	**1509.0**	**42.5**

Nigeria

Nigeria like any other developing country needs budgetary support. The NAIP budget totalling 998 billion was budgeted for in the 2012 financial year (Table 6.3). About 82% of the budget will be supported by the national government. There is a financing gap of about 20%. Most financing of CSA related initiatives is based on donor funding, making these countries susceptible to handouts. Given the importance of CSA in national and local economies, African governments need to provide budgetary support for CSA by allocating their own resources to promising initiatives.

Table 6.3 NAIP and the Financing Gap (N billion)

Sub-sector	No of Projects	2010	2011	2012	2013
Integrated Crops (1) d/	3	19.9	50.3	43.9	31.9
Integrated Crops (2)	32	59.2	51.0	64.5	108.0
Livestock a/	5	4.2	4.2	4.2	4.2
Fisheries	2	1.5	3.1	3.6	2.1
Total - Core	42	84.8	108.6	116.2	146.2
(Total – US$ million equivalent) e/		565.3	724.0	774.7	974.6
Fertilizer b/	2	435.1	435.1	435.1	435.1
Seed	8	2.0	5.8	5.7	3.4
Plant Disease	13	0.01	0.005	0.004	0.004
Dam and Irrigation	9	2.1	2.0	0.8	-
Research and Development c/	9	0.07	0.07	0.07	0.07
Total – Support Services	41	439.2	443.2	441.7	438.6
Gross Total		524.0	551.8	557.9	584.8
Gross Total less Fertilizer		88.9	116.7	122.8	149.7
(US$ million equivalent) e/		592.7	778.0	818.7	998.0

Notes: a/ Total of N16.6 billion over 4 years; b/ Total of N 17402 billion over 4 years; c/ Total of N0.289 billion over 4 years; d/ Excludes budget allocation for 2010; e/ Based on US$1=N150.7.2.

7. Conclusions

Long-term impact of climate change on food and nutritional security and environmental sustainability is continuously gaining attention; particularly in Sub-Sahara Africa that depends heavily on rain-fed agriculture making rural livelihoods and food security highly vulnerable to climate variability such as shifts in growing seasons. This is due to limited economic development and institutional capacity. According to the case studies in Nigeria, Cameroun and DRC, currently, the existing technologies and 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. These three countries need 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.

Climate Smart Agriculture (CSA) is one ofthe 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 resiliencewith the improvement of ecologicalresilience and promotes environmentfriendly intensification of farming systems,herding systems and the efficiency ofsustainable gathering systems. However, there is no clear cut policy on climate smart agriculture in any of the three countries.

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 and 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 carbon emissions.

Moreover, for the future some priority crops and livestock that are suitable for CSA practices across different agro-ecologies in Africa were identify. Exchange of information on these is to be encouraged. Policy interventions are required to promote such exchanges and learning from different parts of the country, sub-region, and regions. Some investment gaps were identified. These are categorized as research, technology, innovation, research, and policy. Policy interventions could be at the regional, sub-regional, and the national level.

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ANNEXES

ANNEX 1: List of Contacted Persons

Dr. Diffang Funge	University of Dschang
Dr. Dixon Okoro	Federal Ministry of Agriculture Abuja, Nigeria
Peter Tarfa	Department of Climate Change, Federal Ministry of Environment, Abuja
Professor Eric Eboh	Agricultural Policy Research Network, Abuja
Wilfred Awung	Cameroon
ZagabeJasperr	CNJCC, DCR

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.

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