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1. INTRODUCTION

The agricultural sector is a key sector of both the global economy and many national economies. It provides livelihoods and basic subsistence needs for millions of people and contributes to the achievement of food security in both developing and developed countries. Worldwide agricultural production is expected to decrease under climate change projections, posing a threat to global food security (IPCC, 2007). However, it is also important to note that agriculture contributes a significant amount of global emissions annually, which would increase with the intensification or expansion of production to meet higher demand.

There is growing acknowledgement that agriculture and food systems need to change, irrespective of climate change (IFAD/FAO/WFP). The last time the world faced such pressure to find a permanent solution to world food insecurity was in the 1960s and 1970s, when food production and distribution could not keep pace with the growing population (primarily in Asia). The response was the Green Revolution: high-yielding, pest/disease resistant varieties of mainly rice and wheat were introduced, and their cultivation was supported through subsidies for inputs such as seed, fertilizer and irrigation (FAO data).

The need for climate-smart agriculture for the world's 500 million smallholder farms cannot be overlooked because they provide up to 80 per cent of food in developing countries; manage vast areas of land (farming some 80 per cent of farmland in sub-Saharan Africa and Asia) and make up the largest share of the developing world's undernourished. As the most vulnerable and marginalized people in rural societies, many of them, who are women heads of household or indigenous peoples, are especially exposed to climate change. They inhabit some of the most vulnerable and marginal landscapes, such as hillsides, deserts and floodplains. They often lack secure tenure and resource rights, and they rely directly on climate-affected natural resources for their livelihoods.

Climate-smart agriculture might have the potential to offer 'triple-win' benefits from increased adaptation, productivity, and mitigation (Lipper *et al*, 2010), providing a possible strategy to address both climate change and food security concerns. Climate-smart agriculture involves the use of different 'climate-smart' farming techniques to produce crops or livestock, which could help reduce pressure on forests for agricultural use as well as potentially maintain or enhance productivity, build resilience to climate change and mitigate the sector's high emissions (Maybeck and Gitz, 2013).

Climate change is adding pressure to the already stressed ecosystems in which smallholder farming takes place. Over the centuries, smallholders have developed the capacity to adapt to environmental change and climate variability, but the speed and intensity of climate change is outpacing their ability to respond. Many of IFAD's smallholder partners are already reporting climate change impacts on the key ecosystems and biodiversity that sustain agriculture. In the absence of a profound step change in local and global action on emissions, it is increasingly likely that poor rural people will need to contend with an average global warming of 4° C above pre-industrial levels by 2100, if not sooner (Betts *et al*, 2011). Such substantial climate change will further increase uncertainty and exacerbate weather-related disasters, drought, biodiversity loss, and land and water scarcity. The major cereal crops (such as wheat, rice and maize) are already at their heat tolerance threshold and with an increase in temperature of between 1.5° C and 2° C, they could collapse (IPCC, 2010). Livestock productivity will be impacted by increased temperature with higher-yielding breeds more likely to be negatively affected than more-robust local breeds. The rise in temperature will, of course, have an impact not only on crops and livestock but also on the pests and diseases they are exposed to. Some farming systems will not remain viable because of climate change, requiring farming system shifts (IPCC, 2010).

Due to constraints, project evaluations are often undertaken after projects have finished, making it too late to make improvements. Even when impact assessment is considered from the beginning, such activity usually does not take into account farmer/participant feedback systematically. This research intends to monitor and explore the implementation level of the CSA practices, evaluate the performance of the practices as well as outcomes which will serve as a feedback mechanism for the stakeholders, in order to keep track of the project, learn lessons from it and also make adjustments where necessary.

This study focuses on monitoring performance, implementation and outcomes of climate smart agriculture in Nwoya District. This study is a mid-term review of the project implementation. It will determine progress being made towards the achievement of outcomes and will identify course correction if needed. This study will focus on identifying the types of CSA practices implemented by the smallholder farmers after the demonstration and examine the performances of the implemented practices. Findings of this study will be incorporated as recommendations for enhanced implementation during the final half of the programme's term.

The overall objective is therefore to examine and monitor the nature and patterns of the Implementation, Performance and Outcomes of the practices of Climate Smart Agriculture in the CCAFS Climate-Smart Villages. The specific objectives of the study are:

1. To assess the different CSA practices carried out by the farmers based on their socio-demographic features.
2. To assess the implementation, performance and outcomes of CSA on smallholder farmers.
3. To identify barriers for wide scale adoption of CSA practices.

2. LITERATURE REVIEW

Agriculture is a fundamental instrument for sustainable development and poverty reduction, and agricultural growth can be a powerful means for reducing inequalities. The 2008 World Development Report found that growth originating in the agricultural sector is two to four times as effective as growth originating in the non-agricultural sector in increasing incomes of the bottom third of the income distribution (WDR, 2007). Agricultural growth has been the main instrument of rural poverty reduction in most developing countries in the recent past, and it is not a surprise that agricultural growth also has a much more direct impact on hunger than general economic growth does (Binswanger-Mkhize *et al.*, 2009). No country has been able to sustain a rapid transition out of poverty without raising productivity in its agricultural sector, according to the recent study of Timmer and Akkus (2008). While in the long run, the way to raise rural productivity is to raise urban productivity (unless the non-agricultural economy is growing, there is little long-run hope for agriculture) and out-migration to these growth areas, historical record is very clear on the important role that agriculture itself plays in stimulating growth in the non-agricultural economy in the short and medium run (Barrett *et al.*, 2010).

2.1 Review of Conceptual Issues

2.1.1 Climate Smart Agriculture

Climate-smart agriculture is an approach to help guide actions to transform and reorient agricultural systems to effectively and sustainably support development and food security under a changing climate. "Agriculture" is taken to cover crop and livestock production, and fisheries and forest management. CSA is not a new production system – it is a means of identifying which production systems and enabling institutions are best suited to respond to the challenges of climate change for specific locations, to maintain and enhance the capacity of agriculture to support food security in a sustainable way.

Climate Smart Agriculture, which is defined by its intended outcomes, rather than specific farming practices, is composed of three main pillars: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change and reducing and/or removing greenhouse gases emissions relative to conventional practices (FAO, 2013). The agricultural technologies and practices that constitute a CSA approach are, in most cases, not new, and largely coincide with those of sustainable agriculture and sustainable intensification. However, under a CSA approach, these are evaluated for their capacity to generate increase in productivity, resilience and mitigation for specific locations, given the expected impacts of climate change. There are three pillars of CSA which are:

1. Sustainably increasing agricultural productivity and incomes
2. Building resilience to climate change
3. Developing opportunities to reduce greenhouse gases emissions compared to expected trends

2.2.1 Monitoring Implementation

Monitoring is the regular observation and recording of activities taking place in a project or programme. It is a process of routinely gathering information on all aspects of the project. To monitor is to check on how project activities are progressing. It is systematic and purposeful observation. Good management practices include regular monitoring on both a short and long-term basis. An effective monitoring process provides ongoing, systematic information that strengthens project implementation. The monitoring process provides an opportunity to compare implementation efforts with original goals and targets and determine whether sufficient progress is being made toward achieving expected results.

2.2.2 Performance Monitoring

Monitoring also involves giving feedback about the progress of the project to the donors, implementers and beneficiaries.

Reporting enables the gathered information to be used in making decisions for improving project performance. Monitoring performance is a process of evaluating some sets of criteria. An effective monitoring and data management system records the performance of all institutions with implementation responsibilities. Performance is the extent and the degree to which a project reaches its targets. To assess performance, it is necessary to select, before the implementation of the project, indicators which will permit to rate the targeted outputs and outcomes.

Performance monitoring is also a strategic approach to management, which equips leaders, managers and stakeholders at various levels with a set of tools and techniques to regularly plan, continuously monitor, periodically measure and review performance of the project in terms of indicators and targets, for efficiency, effectiveness and impact.

2.2.3 Monitoring Outcomes

Outcome monitoring is the periodic measurement of knowledge, behaviours, or practices that a programme or intervention intends to change. Outcome is the result or effect of an action, the result of an intervention, the consequence of an action and the way a thing turns out to be.

2.2.4 Climate Smart Villages

The Consultative Group on International Agricultural Research (CGIAR) Program on Climate Change, Agriculture and Food Security (CCAFS) is working with a number of partners, including national governments and research institutions, to test a range of interventions in Climate-Smart

Villages (CSVs) across West Africa, East Africa, South Asia, Latin America, and Southeast Asia. CCAFS also collaborates with local farmers, community-based organizations, national meteorological institutions, and private sector stakeholders. After potential sites are selected, a steering group of community representatives and researchers work together to identify appropriate CSA options for that village. The community chooses its preferred options through a process that is as participatory and inclusive as possible, encouraging women and more vulnerable groups to participate. For example, in 2014, in Lushoto, Tanzania, researchers worked with women and men farmers to gather local knowledge and skills and then developed CSA packages of practices appropriate for demonstration and adoption in the community.

Climate Smart Villages are sites where researchers, local partners, and farmers collaborate to evaluate and maximize synergies across a portfolio of climate-smart agricultural interventions. Sustainably increasing agricultural productivity is therefore central to the future of global food security and the realization of the Sustainable Development Goals. Now is the time for action, as practices to adapt agriculture to climatic risks take time to root and become effective. Strategies that enhance climate-smart agriculture are the most appropriate starting point for sustainable agriculture.

To address this challenge, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), in collaboration with national programmes, is partnering with rural communities to develop Climate-Smart Villages as models of local actions that ensure food security, promote adaptation and build resilience to climatic stresses. Researchers, local partners, farmers' groups and policy makers collaborate to select the most appropriate technological and institutional interventions based on global knowledge and local conditions to enhance productivity, increase incomes, achieve climate resilience and enable climate mitigation.

2.3 Review of Theoretical Issues

Climate change and food security are two of the most pressing challenges facing the global community today. Improving smallholder agricultural systems is a key response to both. The 2010 FAO report estimates that the number of chronically hungry people in the world has reached a total of 925 million people. About 75% of the worst-affected people reside in rural areas of developing countries, their livelihoods depending directly or indirectly on agriculture (FAO 2009). Strengthening agricultural production systems is a fundamental means of improving incomes and food security for the largest group of food-insecure in the world (World Development Report, 2007; Ravallion & Chen, 2007). As the key economic sector of most low-income developing countries, improving the resilience of agricultural systems is essential for climate change adaptation (Conant, 2009; Parry *et al*, 2007; Adger *et al*, 2003). Improvements in agricultural production systems offers the potential to provide a significance source of mitigation by increasing carbon stocks in terrestrial systems, as well as emissions reductions through increased efficiency (FAO, 2009; Paustian *et al*., 2009, Smith *et al*., 2008).

Agriculture has been and continues to be the most important sector in Uganda's economy. It employs about 65.6% of the population aged 10 years and older (UBOS, 2010). In 2010/11, the sector accounted for 22.5 percent of the country's total GDP (MAAIF 2011). Agricultural exports accounted for 46 percent of total exports in 2010 (MAAIF 2011). The sector is also the basis for much of the industrial activity in the country since most industries are agro-based. Even though its share in total GDP has been declining, agriculture remains important because it provides the basis for growth in other sectors such as manufacturing and services. It is also the sector that provides equal opportunities for employment for both men and women in Uganda

Current Production Practice

The majority of people in Uganda depend on agriculture for their sustenance and livelihoods, and the major farming systems are largely determined by the rainfall pattern (total amount and distribution per year). Farming systems cover a wide range of activities including the production of traditional cash crops (coffee, sugar-cane, cotton and tea), food crops (banana, cassava, maize, sorghum, finger-millet, potatoes and beans) and keeping livestock (cattle, goats, pigs and poultry). Typically, farm operations are by conventional tillage which involves land clearing first and then ploughing and finally disc ploughing using a wide range of implements, though the majority of farmers often use ox plough or the hand hoe.

However, over the years, farmers have badly managed their land largely through the use of conventional tillage leading to severe degradation of the farm land. Consequently, average yields are low. The national situation indicates that land and land resources degradation accounts for over 80% of the annual cost of environmental degradation (Knox *et al*, 2012). Wide spread forest clearing, continuous cultivation, crop residue burning, and overgrazing have exposed land to agents of degradation, thus raising serious concern about conventional tillage. Land degradation is also evident in the dry lands of the cattle corridor of Uganda where land management is threatened by overgrazing by local and mobile pastoralist herds, deforestation by excessive use of fuel wood resources and poor and inappropriate agricultural practice on marginal land. CSA offers farmers a wide range of benefits including increased productivity, better management of resource base and reduction of GHG.

2.3.1 Why Climate Smart Agriculture

Climate-smart agriculture (CSA) helps to address a number of important challenges:

1. *CSA Addresses Food Security, Misdistribution and Malnutrition*

Despite the attention paid to agricultural development and food security over the past decades, there are still about 800 million undernourished and 1 billion malnourished people in the world. At the same time, more than 1.4 billion adults are overweight and one third of all food produced is wasted. Before 2050, the global population is expected to swell to more than 9.7 billion people (United Nations 2015). At the same time, global food consumption trends are changing drastically. For example, increasing affluence is driving demand for meat-rich diets. If the current trends in consumption patterns and food waste continue, it is estimated we will require 60% more food production by 2050 (Alexandratos and Bruinsma 2012). CSA helps to improve food security for the poor and marginalised groups while also reducing food waste globally (CCAFS 2013).

2. *CSA Addresses the Relationship between Agriculture and Poverty*

Agriculture continues to be the main source of food, employment and income for many people living in developing countries. Indeed, it is estimated that about 75% of the world's poor live in rural areas, with agriculture being their most important income source (Lipper *et al*. 2014). As such, agriculture is uniquely placed to propel people out of poverty. Agricultural growth is often the most effective and equitable strategy for both reducing poverty and increasing food security (CCAFS and FAO 2014).

3. *CSA Addresses the Relation between Climate Change and Agriculture*

Climate change is already increasing average temperatures around the globe and, in the future, temperatures are projected to be not only hotter but more volatile too. This, in turn, will alter how much precipitation falls, where and when. Combined, these changes will increase the frequency and intensity of extreme weather events such as hurricanes, floods, heat waves, snowstorms and droughts. They may cause sea level rise and salinization, as well as perturbations across entire ecosystems. All of these changes will have profound impacts on agriculture, forestry and fisheries (FAO, 2013a).

The agriculture sector is particularly vulnerable to climate change because different crops and animals thrive in different conditions. This makes agriculture highly dependent on consistent temperature ranges and water availability, which are exactly what climate change threatens to undermine. In addition, plant pests and diseases will likely increase in incidence and spread into new territories (Grist 2015), bringing further challenges for agricultural productivity.

While climate change will have both positive and negative impacts on crop yields - meaning that for some crops in some areas, yields will rise while others elsewhere suffer - negative impacts have outweighed positive impacts to date (IPCC 2014b). Already, it is estimated that climate change has reduced global yields of wheat by 5.5% and of maize by 3.8% (Lobell *et al*, 2011). By 2090, it is projected that climate change will result in an 8-24% loss of total global caloric production from maize, soy, wheat and rice (Elliott *et al*, 2015). Where these declines in productivity occur will vary. For example, sub-Saharan Africa will be hit particularly hard; it is estimated that across Africa, maize yields will drop by 5% and wheat yields by 17% before 2050 (Knox *et al*, 2012).

The relationship between agriculture and climate change is a two-way street: agriculture is not only affected by climate change but has a significant effect on it in return. Globally, agriculture, land-use change, and forestry are responsible for 19-29% of greenhouse gas (GHG) emissions. Within the least developed countries, this figure rises to 74% (Vermeulen *et al*, 2012; Funder *et al*, 2009). If agricultural emissions are not reduced, agriculture will account for 70% of the total GHG emissions that can be released if temperature increases are to be limited to 2°C. The mitigation options available within the agricultural sector are just as cost-competitive as those established within the energy, transportation and forestry sectors. And they are just as capable of achieving long-term climate objectives (Smith *et al*, 2007). For this reason, mitigation is one of the three pillars of climate-smart agriculture.

In order to further support CSA, it is essential to measure progress and identify successes and problems of CSA interventions (be they pilot initiatives, projects or programmes). Monitoring will check whether activities are meeting the CSA objectives, as well as project milestones and measures of efficiency, and facilitate adjustment of activities taking account of uncertainties. Within the project or programme, accountability and wise use of resources are promoted by monitoring and evaluation (M&E). Good M&E help in such a way to improve the design of future CSA interventions and decision making by stakeholders and constitute a long-term learning process. M&E can thereby especially contribute to the achievement of national mitigation goals, while detailed and adequate monitoring of greenhouse gas emissions can be part of accounting requirements within the framework of the UNFCCC.

2.4 Review of Empirical Issues

At every stage, food provisioning adds to the build-up of greenhouse gases in the atmosphere. If emissions caused by direct and indirect energy use by the agro-food chain were included, the AFOLU share of total greenhouse emissions would increase by one third (FAO, 2011). The contribution of food systems to total GHGs emissions varies among countries and regions, according to the structure of local supply chains. Estimates by the Consultative Group for International Agricultural Research (CGIAR) indicate that in high-income countries, emissions from the pre- and post-production stages equal those from production. In contrast, agricultural production is still the dominant stage in terms of GHG emissions in developing countries (Vermeulen, Campbell and Ingram, 2012).

2.4.1 Impacts of Climate Change on Crops

Climate change impact on the yields of major crops is probably related to issues of food security on which there are many studies. A wide literature on observed and projected impacts on yields includes more than two decades of work since the global assessment by Rosenzweig and Parry (1994) of the potential impact of climate change on world food supply; some other key studies are Parry, Rosenzweig and Livermore (2005), Cline (2007), World Bank (2010), and Rosenzweig *et al*. (2014). Most studies are limited to major crops, and the effects of climate change on many other important crops are much less known. The observed effects of past climate trends on crop production are evident in several regions of the world (Porter *et al.,* 2014), with negative impacts being more common than positive ones. There is evidence that climate change has already negatively affected wheat and maize yields (Table 2.1).

Table 1: Climate Impacts on Selected Crop Yields, Globally and in Tropical Areas, Under Warming of 1.5 °C and 2 °C Above Pre-Industrial Levels Over The 21st Century

Crop	Region	Increase over pre-industrial temperatures 1.5°C	2.0°C
Wheat	Global	2(-6 to +17)	0(--8 to +21
	Tropical	-9(-25 to +12)	-16(-42 to +14)
Maize	Global	-1(-2 to +8)	-6(-38 to +2)
	Tropical	-3(-16 to +2)	-6(-19 to +2)
Soybean	Global	7(-3 to +28)	1(-12 to +34)
	Tropical	6(-3 to +23)	7(-5 to +27)
Rice	Global	7(-17 to +24)	7(-14 to +27)
	Tropical	6(0 to +20)	6(0 to +24)

Note: The figures in parentheses indicate a likely (66 percent) confidence interval.
SOURCE: Adapted from Schleusner *et al*. (2016)

Widely cited estimates show that over the period 1980 to 2008, there was a 5.5 percent drop in wheat yields and a 3.8 percent drop in maize yields globally, compared to what they would have been, had climate remained stable (Lobell, Schlenker and Costa-Roberts, 2011). Several other possible impacts of climate change on the functioning of ecosystems – such as the balance between crops and pests, and effects on pollinators – are difficult to assess and are generally not taken into account by the models used to make projections of crop yields. Within certain limits, a changing climate could have both positive and negative effects on crops. Indeed, increases in temperatures and levels of carbon dioxide in the atmosphere may be beneficial for some crops in some places. Yields of wheat and soybeans, for example, could increase with increased CO_2 concentrations under optimal temperatures. However, while projections of future yields vary according to the scenario, model and time-scale used, there is consistency in the main expected directions of change: yields suffer more in tropical regions than at higher latitudes and impacts are more severe with increased warming (Porter *et al.*, 2014).

Importantly, the IPCC Fifth Assessment Report provides new evidence that crop yields are expected to decline in areas that already suffer food insecurity. It presents projected estimates of changes in crop yields owing to climate change over the 21st century. The data used include results from 91 studies with 1722 estimates of changes in crop yields by Challinor *et al.*, 2014. There are wide variations among the studies, in terms of time-frame, crop coverage, crop and climate models, and emission levels. Some studies include the effects of adaptation measures, but others do not. The scales and geographical coverage also vary, with some estimates being for localities while others are national, regional or global.

2.4.2 Impacts of Climate Change on Livestock

Climate change affects livestock production in multiple ways, both directly and indirectly. The most important impacts are on animal productivity, animal health and biodiversity, the quality and amount of feed supply, and the carrying capacity of pastures. Increasing variability in rainfall leads to shortage of drinking water, an increased incidence of livestock pests and diseases, and changes in their distribution and transmission. It also affects the species composition of pastures, pasture yields and forage quality.

Higher temperatures cause heat stress in animals, which has a range of negative impacts: reduced feed intake and productivity, lower rates of reproduction and higher mortality rates. Heat stress also lowers animals' resistance to pathogens, parasites and vectors (Thornton *et al.*, 2009; Niang *et al.*, 2014). Multiple stressors greatly affect animal production, reproduction and immune status. Research in India found that a combination of climate-related stresses on sheep – for example, excessive heat and lower nutritional intake – had severe impacts on the animals' biological coping mechanisms (Sejian *et al.*, 2012). The effects of higher temperatures may be reduced in intensive cattle, pig and poultry production units, through climate control (Thornton *et al.*, 2009), provided appropriate housing and energy are available. However, projected drier conditions in the extensive rangelands of southern Africa would increase water scarcity; in Botswana, the costs of pumping water from boreholes increases 23 percent by 2050. In the Near East, declining forage quality, soil erosion and water scarcity will most likely be exacerbated in the semi-arid rangelands (Turral, Burke and Faurès, 2011).

Impacts of climate change on animal health are also documented, especially for vector-borne diseases, with rising temperatures favouring the winter survival of vectors and pathogens. In Europe, global warming is likely to increase sheep tick activity, and the risk of tick-borne diseases, in the autumn and winter months (Gray *et al.*, 2009). Outbreaks of Rift Valley fever in East Africa are associated with increased rainfall and flooding due to El

Niño-Southern Oscillation events (Lancelot, de La Rocque and Chevalier, 2008; Rosenthal, 2009; Porter *et al.,* 2014).

2.4.3 Impacts of Climate Change on Incomes and Livelihoods

The effect of climate change on the production and productivity of the agriculture sectors will translate into mostly negative economic and social impacts, with implications for all four dimensions of food security. Climate change can reduce incomes at both the household and national levels. Given the high dependency on agriculture of hundreds of millions of poor and food-insecure rural people, the potential impacts on agricultural incomes – with economy-wide ramifications in low-income countries that are highly dependent on agriculture – are a major concern. By exacerbating poverty, climate change would have severe negative repercussions on food security. Much uncertainty surrounds the future evolution of climate change, its precise impacts and the possible responses. The implications for the environment and society depend not only on the response of the earth system to changes in atmospheric composition, but also on the forces driving those changes and on human responses, such as changes in technology, economies and lifestyle.

The key role of agriculture in supporting the livelihoods of the majority of the world's poor, and their particular vulnerability to climate change, was confirmed in a World Bank study, which compares worst-case and more optimistic scenarios with a scenario of no climate change (Hallegatte *et al.*, 2015). A scenario with high impact climate change, rapid population growth and a stagnant economy indicates that an additional 122 million people would be living in extreme poverty by 2030. With the same level of climate change impacts, but with universal access to basic services, reduced inequality and extreme poverty affecting less than 3 percent of the world's population, the number of additional poor is projected to be just 16 million (Rozenberg and Hallegatte, 2015).

Under the worst-case scenario, much of the forecast increase in the number of poor occurs in Africa (43 million) and South Asia (62 million). Reduced income in the agricultural sector explains the largest share of increased poverty as a result of climate change. This is because the most severe reductions in food production and increase in food prices occur in Africa and India, which account for a large share of the world's poor. The second most important factor leading to increased poverty is health impacts, followed by the impacts of higher temperatures on labour productivity. Recent FAO studies of adaptation to climate changes in smallholder agriculture systems in sub-Saharan Africa show how dry spells, the late onset of rains and high temperatures affect incomes at the farm level. In all cases, climate shocks reduce productivity or harvest value significantly and, in turn, reduce access to food.

The shocks impinge on physical capital, when assets are destroyed – for example, through the death of livestock – or when farmers are forced to sell productive capital, such as cattle, to absorb the income shock. They also reduce farmers' capacity to invest, with negative consequences for future food security.

At the national level, reduced production due to climate change can trigger an increase in the prices of food and feed, negatively affecting the socio-economic status of the whole population and its food security. Such impacts are particularly critical in countries where an important part of the household budget is spent on food. They can be accompanied by major macro-economic effects where agriculture makes an important contribution to national GDP and/ or employment.

Lam *et al.* (2012) model the economic and social implications of climate-change induced modifications in the availability of marine fisheries species in 14 countries in West Africa, by 2050. Using the high range IPCC Special Report on Emission Scenarios (SRES) A1B scenario, they project a decrease in landed fish value of 21 percent, a total annual loss of US$311 million compared to values for 2000, and a loss in fisheries-related jobs of almost 50 percent, with Côte d'Ivoire, Ghana, Liberia, Nigeria, Sierra Leone and Togo suffering the most severe impacts. Most projections of the food price impacts of climate change point to increases, although the magnitude and locations vary considerably across models and climate scenarios. A study that coupled scenarios for population growth and income growth with climate change scenarios looked at the potential impacts under 15 different combinations. Using an optimistic scenario of low population growth and high-income growth, and the mean results from four climate change scenarios, it plotted mean projected price increases by 2050, compared to 2010 levels, of 87 percent for maize, 31 percent for rice and 44 percent for wheat (Nelson *et al.*, 2010).

Climate change may also lead to changes in investment patterns that would lead to reductions in the long-term productivity and resilience of agricultural systems at household and national levels (Antle and Crissman, 1990; Dercon and Christiaensen, 2011; Fafchamps, 1992; Feder, Just and Zilberman, 1985; Heltberg and Tarp, 2002; Kassie *et al.,* 2008; Roe and Graham- Tomasi, 1986; Sadoulet and de Janvry, 1995; Skees, Hazell and Miranda, 1999). All of these responses generally lead to both lower current and future farm profits (Hurley, 2010; Rosenzweig and Binswanger, 1993).

3. METHODOLOGY

3.1 Theoretical Framework

CSA is a continuous and iterative process that aims to combine food security, agricultural development and climate change objectives. This concept implies that the cycle of planning, implementation, monitoring and evaluation is one of continuous learning, knowledge sharing, and advancement towards solutions. As agricultural production is part of a complex food chain, many types of stakeholders must be involved in this process. In order to further support CSA, it is essential to measure progress and identify successes and problems of CSA interventions (be they pilot initiatives, projects or programmes). Monitoring will check whether activities are meeting the CSA objectives, as well as project milestones and measures of efficiency, and facilitate adjustment of activities, taking account of uncertainties. Within the project, accountability and wise use of resources are promoted by monitoring and evaluation. Good monitoring and evaluation help in such a way to improve the design of future CSA interventions and decision making by stakeholders and constitute a long-term learning process.

The process requires communication to organize and maintain commitment of all relevant stakeholders. This research is therefore a midline survey that involves asking simple questions on Knowledge, Attitude, Skills, Interest and Practice to getting feedbacks from household farmers in order to complete the project. The approach incorporates feedback mechanism to build an evidence base that improves decision making, adoption and impact. Lessons learned from this project will provide a basis for concrete recommendations and for identifying further steps which will allow to effectively use science to inform policy, bring stakeholders together and improve efficiency of investments to successfully confront climate change.

3.2 Data Required and Sources

3.2.1 Population and Sample Site

This study was conducted in Nwoya district of Northern Uganda. Nwoya District is one of the newest districts in Uganda. It was established by Act of Parliament and began functioning on 01 July 2010. Prior to that date, it was part of Amuru District. The district lies in the Acholi sub region. It is bordered by Amuru District to the North, Gulu District to the Northeast, Oyam District to the East, Kiryandongo District, Masindi District and Buliisa District to the South. Nebbi District lies to the West of Nwoya District. Nwoya, the main political, administrative and commercial centre in the district, is located approximately 44 kilometres (27 mi), by road, southwest of the city of Gulu, the largest metropolitan area in the sub-region. This location is approximately 330 kilometres (210 mi), by road, north of the city of Kampala, Uganda's capital and largest metropolitan area. The coordinates of the district are: 02 38N, 32 00E. The district is predominantly rural. The 2002 national census estimated the population of the district at 41,010. The district population is growing at an estimated annual rate of 3.3%.

Given those statistics, the projected population of the district in 2016 was approximately 159,500 (Uganda Bureau of Statistics website).

Table 2: Sample Locations and Sample Sizes

District	**Sub-county**	**Sample Size (Household farmers)**
Nwoya	Alero	37
	Anaka	15
	Purongo	16
	Koch Goma	32
Total		100

The target population for this study was all household farmers in Nwoya district. This sampling frame of project participants constituted the population from which a representative sample was drawn for the purpose of this study. Target of 100 household farmers, but 85 household farmers and 154 respondents was used for analysis. This sample size was distributed across the four sub-counties. A multi–stage sampling method was used to select 100 household farmers.

1. Stage 1: In Uganda, Northern Uganda was chosen using simple random sampling.
2. Stage 2: In Northern Uganda, 1 district was chosen (Nwoya district) using simple sampling method.
3. Stage 3: In the district, 4 sub-counties were chosen
4. Stage 4: In the sub-counties, 37, 15, 16 and 32 households were chosen from Alero, Anaka, Purongo and Koch Goma sub-counties respectively by using simple random sampling methods.

4. RESULTS AND DISCUSSIONS

This chapter presents the results of the analysis. This was in line with the three objectives of the study and as indicated in the various methodologies.We start by providing the results of the assessment of the CSA practices.

4.1: Assessment of the Different CSA Practices Carried Out by the Farmers Based on their Socio-Demographic Features.

In this section, we provide the results of Climate Smart Agricultural Practices in Nwoya District of Uganda. We explore the situation for the five different practices including row planting, intercropping, minimum tillage, improved variety and mulching. This is done in order to understand the nature and prevalence of CSA in Uganda.

Table 3: Row Planting Practice with Educational Level of Household Head

	Educational level				Total
	No Education	Primary	Secondary	Superior /Tertiary	
Yes, currently practising No	6 (85.7%)	98 (93.3%)	36 (94.7%)	4 (100%)	144 (93.5%)
Only practised in the past	0 (0%)	1 (1.0%)	2 (5.3%)	0 (0%)	3 (1.9%)
Total	1 (14.3%)	6 (5.7%)	0 (0%)	0 (0%)	7 (4.5%)
	7 (100)	105 (100)	38 (100)	4 (100)	154 (100)

Pearson Chi-Square= 161.691 (0.000)
Significance level is in parenthesis.

Table 3 above shows that 7 household head respondents are with no education, 105 household head respondents have primary education, 38 household head respondents have secondary education while 4 household head respondents have superior education. Six (6) or 85.7% of the household heads with no education are currently practising row planting while 1 or (14.3%) of the household heads with no education have only practised it in the past. Ninety-eight (98) or 93.3% household head respondents with primary education are currently practising row planting, 1 or (1.0%) household head respondent has not practised row planting while 6 or 5.7% of the household head respondents have practised row planting in the past.

Out of the 38 household head respondents, 36 or 94.7% with secondary education are currently practising row planting while 2 or 5.3% are not practising row planting. Only 4 or 100% respondents with tertiary education are currently practising row planting. The Chi test is 161.691 and reveals that there is no significant difference between the educational level of the household head and the way they practised row planting as a way of CSA.Table 4.2 presents the CSA practices in intercropping along educational level of household heads.

Table 4: Intercropping Practice with Educational Level of Household Head

	Educational level				Total
	No Education	Primary	Secondary	Superior/ Tertiary	
Yes, currently practising	7 (100%)	91 (86.7%)	35 (92.1%)	3 (75%)	136 (88.3%)
No	0 (0%)	5 (4.7%)	1 (2.6%)	0 (0%)	6 (3.9%)
Only practised in the past	0 (0%)	9 (8.6%)	2 (5.3%)	1 (25%)	12 (7.8%)
Total	7 (100)	105 (100)	38 (100)	4 (100)	154 (100)

Pearson Chi-Square= 158.551 (0.000)
Significance level is in parenthesis.

From Table 4 above, 7 (100%) household head respondents with no education are currently practising intercropping, 91 (86.7%) household head respondents with primary education are currently practising intercropping, 35 (92.1%) household head respondents with secondary education are currently practising intercropping. None of the household head respondents with no education has either practised intercropping in the past or not practising intercropping. 5 (4.7%) household head respondents with primary education have not practised intercropping while 9 (8.6%) have practised it in the past. One 1 (2.6%) respondent with secondary education is not practising intercropping and 2 (5.3%) have practised it in the past.

This indicates that majority of farmers who are currently practising intercropping have primary education and therefore shows that the respondents have a form of education to understand how CSA practices are being carried out.The Chi test is 158.551 and reveals that there is no significant difference between the educational level of the household heads and the way they practised intercropping as a way of CSA.Table 4.3 presents the CSA practices in improved varieties along educational level of household heads.

Out of the respondents, 57 or 37.0% household respondents are currently practising improved varieties, 82 or 53.2% household head respondents are not practising improved varieties while 15 or 9.7% household head respondents have practised improved varieties in the past.7 household head respondents have no education, 105 household head respondents have primary education, 38 household head respondents have secondary education while only 4 household head respondents have tertiary education. The Chi test is 167.955 and reveals that there is no significant difference between the educational level of the household heads and the way they practised improved varieties as a way of CSA.

Table 5: Improved Varieties Practice with Educational Level of Household Head

	Educational level				Total
	No Education	Primary	Secondary	Superior /Tertiary	
Yes, currently practising	2 (28.6%)	34 (32.4%)	17 (44.7%)	4 (100%)	57 (37.0%)
No	5 (71.4%)	62 (59.0%)	15 (39.5%)	0 (0%)	82 (53.2%)
Only practised in the past	0 (0%)	9 (8.6%)	6 (15.8%)	0 (0%0	15 (9.7%)
Total	7 (100)	105 (100)	38 (100)	4 (100)	154 (100)

Pearson Chi-Square= 167.955 (0.000)
Significance level is in parenthesis.

Table 6 presents the CSA practices in improved varieties along educational level of household heads.

Out of the 154 respondents who are currently practising minimum tillage, 7 (100%) with no education have not practised minimum tillage, those with primary education, 7 (6.7%) are currently practising, 91 (86.6%) have not practised while 7 (6.7%) have only practised minimum tillage in the past. For those with secondary education 3 (7.9%) are currently practising, 32 (84.2%) are not practising while 3 (7.9%) respondents only practised in the past. For those with tertiary education, only 4 (100%) have not practised minimum tillage before.The Chi test is 156.929 and reveals that there is no significant difference between the educational level of the household heads and the way they practised minimum tillage as a way of CSA.

Table 6: Minimum Tillage Practice with Educational Level of Household Head

	Educational level				Total
	No Education	Primary	Secondary	Superior /Tertiary	
Yes, currently practising	0 (0%)	7 (6.7%)	3 (7.9%)	0 (0%)	10 (6.5%)
No	7 (100%)	91 (86.6%)	32 (84.2%)	4 (100%)	134 (87.0%)
Only practised in the past	0 (0%)	7 (6.7%)	3 (7.9%)	0 (0%)	10 (6.5%)
Total	7 (100)	105 (100)	38 (100)	4 (100)	154 (100)

Pearson Chi-Square= 156.929 (0.000)
Significance level is in parenthesis.

Table 7 presents the CSA practices in mulching along educational level of household heads. The Table shows that 1 (or 14.3%) household head respondent with no education, 20 or 19.0% household head respondents with primary education, 12 or 31.6% household head respondents with secondary education and no household head respondent with tertiary education are currently practising mulching. Out of 103 or 66.9% household head respondents who are not practising mulching, 6 or 85.7% have no education, 69 or 65.7% have primary education, 25 or 65.8% have secondary education while 3 or 75% have tertiary education. 18 or 11.7% household respondents have only practised mulching in the past out of which 16 or 15.2% have primary education, 1 (or 2.6%) has secondary education while 1 (or 25%) is with tertiary education.The Chi test is 163.848 and reveals that there is no significant difference between the educational level of the household heads and the way they practised mulching as a way of CSA.

Table 7: Mulching Practice with Educational Level of Household Head

	Educational level				Total
	No Education	Primary	Secondary	Superior/Tertiary	
Yes, currently practising	1 (14.3%)	20 (19.0 %)	12 (31.6%)	0 (0%)	33 (21.4 %)
No	6 (85.7%)	69 (65.7 %)	25 (65.8%)	3 (75%)	103 (66.9 %)
Only practised in the past	0 (0%)	16 (15.2 %)	1 (2.6%)	1 (25%)	18 (11.7 %)
Total	7 (100)	105 (100)	38 (100)	4 (100)	154 (100)

P Pearson Chi-Square= 163.848 (0.000)
Significance level is in parenthesis.

Table 8 presents the CSA practices in row planting along with household type. The Table reveals that 123 or 95% respondents who are currently practising row planting are dual headed households. Three or 2.3% respondents who are dual headed households are not practising row planting while 3 or 2.3% dual headed household respondents have practised row planting in the past. Thirteen (13) or 86.7% female headed households are currently practising row planting, 2 or 13.3% female headed respondents have only practised in the past while none of them is not practising. For male headed households, 8 or 80% respondents are currently practicing row planting, no respondent is not practising while 2 or 20% only practised row planting in the past.The Chi test is 165.165 and reveals that there is no significant difference between the household type and the way they practiced row planting as a way of CSA.

Table 8: Row Planting Practice with Household Type

	Type of household			Total
	Dual headed household	Female headed household	Male headed household	
Yes, currently practising	123 (95%)	13 (86.7%)	8 (80%)	144 (93.5%)
No	3 (2.3%)	0 (0%)	0 (0%)	3 (1.9%)
Only practised in the past	3 (2.3%)	2 (13.3%)	2 (20%)	7 (4.5%)
Total	129 (100)	15 (100)	10 (100%)	154 (100)

Pearson Chi-Square= 165.165 (0.000)
Significance level is in parenthesis.

Table 9 presents the CSA practices in intercropping along with household type.

Table 9: Intercropping Practice with Household Type

	Type of household			Total
	Dual headed household	Female headed household	Male headed household	
Yes, currently practising	115 (89.1%)	14 (93.3%)	7 (70%)	136 (88.3%)
No	6 (4.7%)	0 (0%)	0 (0%)	6 (3.9%)
Only practised in the past	8 (6.2%)	1 (6.7%)	3 (30%)	12 (7.8%)
Total	129 (100)	15 (100)	10 (100)	154 (100)

Pearson Chi-Square= 163.422 (0.000)
Significance level is in parenthesis.

From the table above, of the 136 (88.3%) respondents who are currently practising intercropping, 115 (89.1%) respondents are from dual headed households, 14 (93.3%) respondents are from single headed households while 7 (70%) are from male headed households. Six (4.7%) respondents are not practising intercropping and they are all from dual headed households. Twelve (7.8%) respondents have only practised intercropping from the past and 8 (6.2%)

are dual headed, 1 (6.7%) is female headed while 3 (30%) are male headed households.
The Chi test is 163.422 and reveals that there is no significant difference between the household type and the way they practiced intercropping as a way of CSA.

Table 10 presents the CSA practices in improved varieties along with household type.For the practice of improved varieties, 129 respondents are from dual headed households, 15 are from female headed households while 10 are from male headed households. The Chi test is 167.121 and reveals that there is no significant difference between the household type and the way they practised improved varieties as a way of CSA.

Table 10: Improved Varieties Practice with Household Type

	Dual headed household	Female headed household	Male headed household	
Yes, currently practising	53 (41.1%)	3 (20%)	1 (10%)	57 (37.1%)
No	61 (47.3%)	12 (80%)	9 (90%)	82 (53.2%)
Only practised in the past	15 (11.6%)	0 (0%)	0 (0%)	15 (9.7%)
Total	129 (100)	15 (100)	10 (100)	154

Pearson Chi-Square= 167.121 (0.000)
Significance level is in parenthesis.

Table 11 presents the CSA practices in minimum tillage along with household type. From Table 4.9, 154 respondents are from dual headed, female headed or male headed households. For dual headed households, 9 or 7.0% respondents are currently practising minimum tillage, 113 or 87.6% respondents are not practising it while 7 or 5.4% respondents have practised it in the past. For female headed household, 1 (or 6.67%) respondent is currently practising minimum tillage, 12 or 80% respondents are not practising it while 2 or 13.3% respondents have only practised it in the past. For male headed household, no respondent is currently practising minimum tillage, 9 or 90% respondents are not practising it while only 1 (or 10%) respondent has practised it in the past.The Chi test is 157.308 and reveals that there is no significant difference between the household type and the way they practised minimum tillage as a way of CSA.

Table 11: Minimum Tillage Practice with Household Type

	Dual headed household	Female headed household	Male headed household	
Yes, currently practising	9 (7.0%)	1 (6.67%)	0 (0%)	10 (6.5%)
No	113 (87.6%)	12 (80%)	9 (90%)	134 (87.0%)
Only practised in the past	7 (5.4%)	2 (13.3%)	1 (10%)	10 (6.5%)

Total	129 (100)	15 (100)	10 (100)	154 (100)

Pearson Chi-Square= 157.308 (0.000)

Table 12: Mulching Practice with Household Type

	Dual headed household	Female headed household	Male headed household	
Yes, currently practising	31 (24.0%)	2 (13.3%)	0 (0%)	33 (21.4%)
No	86 (66.7%)	10 (66.67%)	7 (70%)	103 (66.9%)
Only practised in the past	12 (9.3%)	3 (20%)	3 (30%)	18 (11.7%)
Total	129 (100)	15 (100)	10 (100)	154 (100)

Pearson Chi-Square= 162.457 (0.000)
Significance level is in parenthesis.

Table 12 above shows that 31 (24.0%) dual headed household respondents, 2 (13.3%) female headed household respondents and no male headed household respondent are currently practising mulching. Eighty-six (66.7%) dual headed household respondents, 10 (66.67%) female headed household respondents and 7 (70%) male headed household respondents are not practising mulching, while 12 (9.3%)

dual headed household respondents, 3 (20%) female headed household respondents and 3 (30%) male headed household respondents have only practised mulching in the past.The Chi test is 162.457 and reveals that there is no significant difference between the household type and the way they practised mulching as a way of CSA.

Table 13 presents the CSA practices in row planting along with rearing of livestock.From the 154 respondents, 144 or 93.5% respondents that are currently practising row planting have either reared or are still rearing livestock. One hundred and thirty-five or 93.8% currently practising row planting are rearing livestock while 9 or 90% who are not rearing livestock are practising row planting. 3 or 2.08% respondents rearing livestock are not practising row planting while 7 or 4.5% respondents from which 6 have practised row planting in the past are rearing livestock.The Chi test is 155.928 and reveals that there is no significant difference between rearing of livestock and the way they practised row planting as a way of CSA.

Table 13: Row Planting Practice with Rearing of Livestock

	Rearing livestock		Total
	Yes	No	
Yes, currently practising	135 (93.8%)	9 (90%)	144 (93.5%)
No	3 (2.08%)	0 (0%)	3 (1.9%)
Only practised in the past	6 (4.17%)	1 (10%)	7 (4.5%)

Total	144 (100)	10 (100)	154 (100)

Pearson Chi-Square= 155.928 (0.000)
Significance level is in parenthesis.

Table 14 presents the CSA practices in intercropping along with rearing of livestock.From the table, out of the 154 respondents, 144 respondents are rearing livestock while 10 respondents are not rearing livestock. Ten or 100% respondents currently practising intercropping are not rearing livestock whereas, 126 or 87.5% respondents currently practising intercropping are rearing livestock.The chi test is 156.425 and reveals that there is no significant difference between rearing of livestock and the way they practised intercropping as a way of CSA.

Table 14: Intercropping Practice with Rearing of Livestock

	Rearing livestock		Total
	Yes	No	
Yes, currently practising	126 (87.5%)	10 (100%)	136 (88.3%)
No	6 (4.17%)	0 (0%)	6 (3.9%)
Only practised in the past	12 (8.33%)	0 (0%)	12 (7.79%)
Total	144 (100)	10 (100)	154 (100)

Pearson Chi-Square= 156.425 (0.000)
Significance level is in parenthesis.

Table 15 presents the CSA practices in improved varieties along with rearing of livestock.

Table 15: Improved Varieties Practice with Rearing of Livestock

	Rearing livestock		Total
	Yes	No	
Yes, currently practising	53 (36.8)	4 (40%)	57 (37.0%)
No	78 (54.2%)	4 (40%)	82 (53.2%)
Only practised in the past	13 (9.03%)	2 (20%)	15 (9.7%)
Total	144	10 (100)	154 (100)

Pearson Chi-Square= 156.544 (0.000)
Significance level is in parenthesis.

Table 16 presents the CSA practices in minimum tillage along with rearing of livestock.Table 4.13 above shows that of the 154 respondents, 144 respondents are rearing livestock while 10 respondents are not rearing livestock. 53 or 36.8% respondents rearing livestock are currently practising improved varieties form of CSA practice, 78 or 54.2% respondents who are rearing livestock are not practising improved varieties while 13 or 9.03% respondents rearing livestock have practised improved varieties in the past. Four (4) or 40% respondents not rearing livestock are currently practising improved varieties, 4 or 40% respondents not rearing livestock are not practising improved varieties while

2 or 20% respondents not rearing livestock only practised improved varieties in the past.The Chi test is 156.444 and reveals that there is no significant difference between rearing of livestock and the way they practised improved varieties as a way of CSA.

Table 16: Minimum Tillage Practice with Rearing of Livestock

	Rearing livestock		Total
	Yes	No	
Yes, currently practising	9 (6.25%)	1 (10%)	10 (6.49%)
No	125 (86.8%)	9 (90%)	134 (87.0%)
Only practised in the past	10 (6.9%)	0	10 (6.5%)
Total	144 (10	10 (100)	154 (100)

Pearson Chi-Square= 155.914 (0.000)
Significance level is in parenthesis.

Out of 154 respondents who responded to this question, 144 are rearing livestock while 10 are not rearing livestock. 9 or 6.25% of those rearing livestock are currently practising minimum tillage, 125 or 86.8% are not practising minimum tillage while 10 or 6.9% have only practised it in the past. 9 or 90% respondents who are not practising minimum tillage are not rearing livestock while 1 or 10% respondent not rearing livestock is currently practising minimum tillage. The Chi test is 155.914 and reveals that there is no significant difference between rearing of livestock and the way they practised minimum tillage as a way of CSA.

Table 17 presents the CSA practices in mulching along with rearing of livestock.

Table 17: Mulching Practice with Rearing of Livestock

	Rearing livestock		Total
	Yes	No	
Yes, currently practising	29 (20.1%)	4 (40%)	33 (21.4%)
No	98 (68.1%)	5 (50%)	103 (66.9%)
Only practised in the past	17 (11.8%)	1 (10%0	18 (11.69%)
Total	144 (100)	10 (100)	154 (100)

Pearson Chi-Square= 157.217 (0.000)
Significance level is in parenthesis.

Table 17 above shows that 33 or 21.4% respondents who are rearing livestock or not rearing livestock are currently practising mulching. 103 or 66.9% respondents who are rearing or not rearing livestock are not practising mulching while 18 or 11.69% respondents who are rearing or not rearing livestock have practised mulching in the past.The Chi test is 157.217 and reveals that there is no significant difference between rearing of livestock and the way they practised mulching as a way of CSA.

This shows that more household farmers rear livestock together with farming and therefore practise mixed farming. According to Uganda Climate Smart Agriculture Programme, 2015-2020, livestock share to the GDP is currently projected at 1.7%. In recent years, livestock population has been estimated to grow at 1.4, 2.5, 4.3 and 3.0 for cattle, sheep, goat and chicken respectively.

4.2: Monitoring Implementation, Performance and Outcomes of Climate Smart Agriculture.

4.2.1: Monitoring Implementation of Climate Smart Agriculture

Indicator for monitoring implementation of the climate smart agriculture is number of household framers carrying out the different CSA practices.All the farmers who were interviewed had adopted at least one practice within the portfolio of CSA practices. Results from the survey show that 90.48% of farmers are currently practising row planting, 7.14% practised row planting in the past while 2.38% are not practising row planting. 84.52% of farmers are currently practising intercropping, 8.33% only practised intercropping in the past while 7.14% of farmers are not practising intercropping. 38.1% of farmers are currently planting improved varieties of seedlings, 8.33% of farmers only planted improved varieties in the past while 53.57% of respondent farmers are not planting improved varieties.5.95% of respondents are currently practising minimum tillage, 7.14% of respondents practised in the past while 86.9% of respondents are not practising minimum tillage. 20.24% of respondents are currently practising mulching, 11.9% only practised in the past while 67.86% are not practising.

The survey shows that majority of the farmers are practising row planting and intercropping more than the other CSA practices. The level of adoption for minimum tillage and mulching are lower because they are newer practices to farmers that require changes in the farming system.

4.2.2: Monitoring Performance of CSA Practices

Indicators for measuring performance include increase in yield, increase in income and control of pests and diseases as a result of the different climate smart agriculture practices.

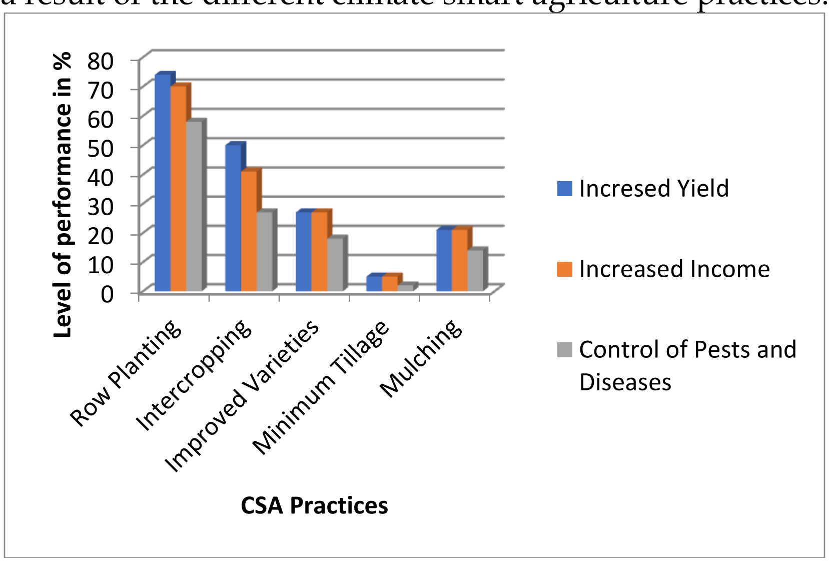

Figure 1: CSA Practices

Row planting has higher percentage for high performance in terms of yield, income and control of pests and diseases. Under certain conditions, CSA has been found to increase crop yields, enhance carbon content in soils and maintain soil moisture (FAO, 2014). When CSA is used in highland areas, it may further enhance crop production and resilience, even in highly degraded soils due to the interactive effects of improved plant nutrition and soil moisture (FAO, 2014).

4.2.3: Monitoring Outcomes of CSA Practices

Indicator for measuring outcome is the reduced time spent on the field since the implementation of the different climate smart agriculture practices.Results indicate that of all the different CSA practices adopted by the farmers, row planting (44%) has helped farmers spend less time on the field, followed by intercropping (26.6%), improved varieties (17.4%), mulching (9.2%) and minimum tillage (2.8%). The respondents confirmed that they spend more time on the field when practising intercropping as against reduced time spent when practicing row planting. This is because in planting different crops in intercropping, each crop takes its time and therefore implies more time on the field.

The respondents stated that improved varieties have been difficult to get and even when they are available, they are most times bad seedlings which do not give much yield as expected. This makes them prefer to use their local seedlings. They acknowledged that it is stressful getting mulch and it takes time to gather. If at all mulch is got, it sometimes allowed for attack of insects and different pests on the crop being mulched. Minimum tillage did not give enough yields as expected, so, they prefer to dig and plant.

4.4: Barriers for Wide Scale Adoption of the CSA Practices

The adoption of CSA practices in Uganda is fraught with certain barriers. These include:

1. Gender inequality
2. Lack of capital and limited farm inputs
3. Limited access to information

4.4.1: Gender Inequality

Gender inequality can hinder adoption of climate-smart strategies. Men, especially heads of household, make the broad management decisions of land allocation, labour organization, cropping/animal rearing patterns and income expenditure. From the study, majority of the women indicated that they have little or no say when it comes to decision making in the family which in turn affects decision on what is done on the farm. The women also complained that they are not allowed to take ownership and implement changes at the farm level, and do not have the resources to do so. For instance, women in Africa often have less access than men to resources such as land, inputs, credit, education, and extension services, all of which may be important to support transitions to CSA.

4.4.2: Lack of Capital and Limited Farm Inputs

Non-availability and poor access to high-yielding seeds and breeds are also notable barriers to the adoption of CSA. Often, CSA requires special seeds for cover crops or intercrops, which are more difficult to obtain if they are species that have not traditionally been grown locally. Unless efficient and reliable input supply chains are established, input barriers will continue to be a hindrance to adoption of CSA.

Smallholder farmers aiming to adopt CSA practices are often constrained by inadequate cash to invest in the land, equipment, labour, seeds, breeds and other farm inputs. As noted by Milder, *et al*. (2011), CSA is generally more profitable in the long-term compared to conventional farming, but achieving these long-term benefits requires initial investment, which is often prohibitively expensive or risky for small farmers to undertake on their own. Vulnerable farmers are especially risk averse due to household food security concerns, and there is little room for error. In addition, while many farmers reap benefits in the first year of practising CSA, others do not realize increased yields or profitability for 3-7 years (Hobbs, 2007). During this time, farmers sometimes choose to abandon CSA. Thus, long-term adoption is more likely when CSA provides significant benefits in the first or second year. Such immediate benefit is more likely when CSA is promoted in conjunction with good agronomic practices, improved seeds, and sometimes inorganic fertilizers.

4.4.3: Limited Access to Information

The farmers identified that they have limited information and also lack access to knowledge about the short and long-term benefits of CSA practices. Information is a powerful tool for enhancing adaptation to climate change and variability. However, African smallholder farmers either do not have access to appropriate information or are unable to fully utilize existing information.

Successful adaptation requires recognition of the necessity to adapt, knowledge about available options, the capacity to assess the options, and the ability to choose and implement the most suitable ones. In terms of climate change, this can be demonstrated through acquisition and dissemination of information on weather hazards. Once such information becomes more available and understood, it is possible to analyse, discuss, and develop feasible adaptation measures. Building adaptive capacity requires a strong unifying vision, scientific understanding of the problems, openness to face challenges, pragmatism in developing solutions, community involvement and commitment at the highest political levels. Inadequately trained and skilled personnel can limit a community's or a nation's ability to implement adaptation options.

5. SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1: Summary of Findings

From the study conducted at Nwoya District of Northern Uganda, it is established that quite a number of household farmers have adopted at least one of the assessed climate smart agricultural practices. Adoption of these practices has increased yield and income, controlled pests and diseases and also reduced time spent on the farm. It was observed that more males are practising CSA than women. Most of the household heads have primary education. The respondents are more of dual-headed household type and are rearing livestock. There are more farmers practising row planting and intercropping than those practising, minimum tillage, mulching and those planting improved varieties.

5.2: Conclusion

CSA contributes to a cross-cutting range of development goals. It needs to be implemented using an integrated, cross-sectoral approach to agriculture and food security that links it to other aspects of sustainable development, poverty reduction and economic growth. CSA policies and programmes, as with all cross-sectoral development programmes, need to be developed so that they are aligned among all levels of government. This requires an understanding of the structure and functioning of each level of government. Comprehensive capacities need to be developed because in many countries, local-level capacity

development has not been included as part of the decentralization processes.
This study shows that majority of the farmers are implementing row planting and intercropping because it is most beneficial to them considering its indicators: crop yield, income, control of pests and diseases and reduced time.

One great strength of the Climate-Smart Village approach is its inclusiveness in bringing together farmers, policy makers, scientists and local organizations to work on a portfolio of practices to adapt agriculture to climate change. Integrating the model into existing or proposed government policies can ensure the food and livelihood security of millions of farmers living in regions vulnerable to climate change.

To create an enabling environment for the development and mainstreaming of CSA in the overarching national plan, appropriate institutions with effective and transparent governance structures are needed. These institutions would coordinate the division of sectoral responsibilities and the work done by national local institutions that will incorporate CSA strategies into legal and regulatory frameworks. Regulations need to be adapted to country environments and accompanied by other supporting incentives if CSA interventions are to be successful in changing behaviour and providing additional incentives for advancing CSA.

Investment in CSA brings long-term gains in productivity, builds resilience, reduces GHG emissions and increases carbon sequestration. The most successful programmes often blend sources of funding. Incentive measures need to focus on overcoming barriers to adoption of CSA practices. Price and non-price measures are needed to support transition to CSA. Behavioural change is also an important element. Price support certainly has a role to play in countries affected by climate change, but often other forms of support (regulations, incentives, capacity development, investments in technology, innovation, efficiency gains and infrastructure, connectivity or the broader enabling environment, social protection and safety nets, and use of social capital) are more effective in paving the way for CSA.

Civil society, the private sector and financial institutions all play vital roles in implementing CSA. These groups should work jointly with key national line ministries and development agencies and donors through an efficient stakeholder consultation process.

5.3 Policy Recommendations

1) Creating awareness about climate change and what CSA can do

Many African smallholder farmers and farm communities experience low crop and animal yields but are unaware that this is partly as a result of climate change. Many are not aware of what to do to remedy the situation. The current climate change discourse is very much promoted by international NGOs and some civil society organizations with little contribution from local farmers and communities. An indigenous (African) critical consciousness to climate change is still lacking. It is therefore important that this consciousness is cultivated and raised at all levels in order to change perceptions of climate change for Africa to take responsibility for addressing the challenges it presents. Most of the challenges can be addressed through adoption of CSA. Whereas resource constraints may limit the practice of CSA, increased consciousness about climate change can enable farmers and farm communities to generate the resources to enable them practice CSA.

2) Facilitating access to finance and credit

Several approaches have been used to overcome the dual financial constraints of the initial investment required for CSA and the potential for negative returns for several years after adoption. Both of these constraints can be overcome by providing low-cost inputs, extending credit to farmers through direct loans or establishment of community financing operations, and educating farmers about the benefits of CSA and ways to improve its profitability. Other rural finance mechanisms can also help farmers overcome the short-term investment hurdle to adopt CSA practices that are more profitable and sustainable in the longer term.

3) Mainstreaming Gender Equality in CSA Initiatives

Climate-smart agricultural initiatives are much more likely to achieve their desired outcomes if they encourage women to take ownership and implement changes at the farm level, ensure that women have the resources to do so by reforming institutional arrangements (structure), and work with men to ensure that they value the contributions and ideas of women with regard to this role (relations)

4) Facilitating Information and Knowledge use in Climate Change and CSA

Farmers and farm communities need to appreciate the need to adopt CSA practices. This appreciation in turn necessitates availability of information explaining the need for CSA adoption. Provision of information and knowledge about the short and long-term benefits of CSA practices, for example CSA's ability to increase yields by fostering biological processes and management practices that enhance soil fertility, pest and weed control regardless of use of agrochemicals, is a good strategy. Strengthening the capacity of farmers and local communities to understand climate change as well as appreciate the benefits of CSA requires an initial critical mass of personnel capable of instilling into farmers information and knowledge about climate change. People need to be trained to collect, collate and disseminate information about weather hazards and to facilitate analysis, discussion and development of feasible adaptation measures. Nonetheless, building overall adaptive capacity requires a strong, unifying vision, scientific understanding of challenges, openness, pragmatism in developing solutions, community involvement and commitment at the highest political levels.

5) Enhancing the Capacity of Farmers to adopt and use New Technologies and Innovations

The ability of farmers to apply new technologies and innovations is an important determinant of CSA adoption. Farmers need to be sensitized on existing technologies and innovations to appreciate and adopt them. Sensitization and awareness creation on existing new technologies and innovations is key to promoting adoption and strengthening adaptive capacity. However, new technologies and innovations are costly and sometimes complicated to apply; so, farmers must either have the resources, receive subsidies or are given incentives to adopt them. Availability of markets, especially for value added products can spur investment in new CSA technologies and innovations and therefore promote adoption.

Slow adaptation to climate change in Africa is partly attributed to low technology adoption. Most agrarian communities are used to traditional technologies that were over generations inculcated into them informally within household and community settings. Any technology not inculcated through early socialization or seen to disrupt the existing livelihood systems will not be accepted and assimilated easily. Therefore, building the capacity of farmers through demonstration, exchange visits and incorporation of socio-cultural aspects is an essential component of any technology transfer package. Technology dissemination should embrace participatory and cross-sector approaches to ensure effective smallholder involvement and sustainability. Overall, enhanced farmer education can speed up technology dissemination and adoption of CSA.

6) Making Farm Equipment, Inputs and Materials affordable to Farmers

Lack of or inadequate financial resources have been identified as a limiting factor to the acquisition of farm inputs and materials needed for successful practice of CSA. This barrier can be removed by making farm inputs and materials affordable to farmers in various ways including:

a) Facilitating access to finance: Compared to conventional farming, some CSA practices require substantial investments that need to be made upfront. Such investments are generally more profitable in the long-term (3-7 years) than in the short-run. Yet, majority of smallholder farmers in Africa are financially constrained to undertake such initial investments on their own. Considering that adoption is more likely when benefits are anticipated in the short-run, smallholder farmers need financial assistance to enable them to practice CSA. Such assistance can be in the form of provision of credit at low interest rates.

b) Provision of subsidies that are eventually phased out gradually over time.
c) Removal of or reduction in import duties on farm equipment, tools and other inputs.
d) Educating farmers about the benefits of CSA and ways to improve its profitability.
e) Linking farmers to community micro-credit finance institutions

7) Promoting CSA Success Stories and Opportunities

For a farmer, life is filled with calculated and uncalculated risks. Therefore, many farmers will be naturally risk averse in their adoption of new ideas. For CSA to be successfully adopted by farmers, it will be important to remember this concept in the presentation of opportunities. Particular emphasis should be put on the successes of CSA and opportunities for farmers to limit risk. There are many successes of CSA both from research and in the field. Identifying and promoting these successes will enhance adoption.

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Centre for Sustainable Development

ABOUT CENTRE FOR SUSTAINABLE DEVELOPMENT (CESDEV)

The Centre for Sustainable Development (CESDEV) was established by the University of Ibadan through Senate paper 5386 in May 2010 as a demonstration of the University's commitment to Sustainable Development. It was based on the need to provide intellectual platform for identification of issues germane to sustainable development, critically analyse them, and provide leadership in finding enduring solutions that will enhance sustainable development.

The establishment of CESDEV was sequel to series of events, paramount among which was the winning of a USD 900,000 grant from the MacArthur Foundation to establish the Master's in Development Practice (MDP) Programme. The University of Ibadan was one of the ten original Universities that won the grant in a global competition involving over 70 Universities. Further brainstorming led to defining the composition of the emerging Centre beyond the MDP Programme. It was resolved that a number of development programmes that were "hanging in the balance" be moved to the Centre. The **Centre for Sustainable Development** (CESDEV) thus became a Teaching and Research Centre with a mandate in multi- and inter-disciplinary approach to Sustainability issues affecting not just our continent but the whole universe. The Centre is designed to be a Teaching, Research and Development unit in the University. Presently, CESDEV has the following academic and outreach programmes:

- Development Practice Programme (DPP)
- Tourism and Development Programme (TODEP)
- Indigenous Knowledge and Development Programme (IKAD)
- Sustainable Integrated Rural Development in Africa Programme (SIRDA)
- Climate and Society Programme (CSP)
- Environmental Protection and Natural Resources Programme (EPNARP)
- Leadership and Governance Programme (LGP)
- Annual Ibadan Sustainable Development Summit (ISDS)

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