Adoption of climate smart technologies by selected smallholder farmers of Kigorobya and Buseruka sub counties in Hoima district

By

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DEDICATION

I dedicate this work to God, my wife, my children and my parents. Without you, my life would fall apart. I might not know where the life's road will take me, but walking with you, through this journey has given me strength. My wife, you are everything for me, without your love and understanding I would not be able to make it. To you my parents, you have given me so much, thanks for your faith in me, and for teaching me that I should never surrender. To my lovely Children: Shaka Simpson Ukunda, Mukiza Simpson Arshavin, Kirabo Simpson Achsah, Ngabo Simpson Asshur and Guma Simpson Elisha, thanks for the patience exhibited when you would accept to miss out your parental care some days during my study period.

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May the Almighty God Reward You All Abundantly

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ABBREVIATIONS

EMO	:	Effective Micro Organisms
FACE	:	Face Air Carbon Enrichment
FAO	:	Food and Agriculture Organization
FDGs	:	Focus Group Discussions
GDP	:	Gross Domestic Product
HDLG	:	Hoima District Local Government
IMO	:	Indigenous Micro Organisms
IPCC	:	Inter-governmental Panel on Climate Change
KIIs	:	Key Informant Interviews
LC1	:	Local Council 1(one)
MSC	:	Masters of Science
NARO	:	National Agricultural Research Organisation
NEMA	:	National Environment Management Authority
SSI	:	Semi Structured Interview
UNFCCC	:	United Nations Framework Convention on Climate Change

ABSTRACT

The study sought to investigate the adoption of climate smart technologies among selected smallholder farmers in Buseruka and Kigorobya sub-counties in Hoima district. The study had three objectives; evaluating the impacts of climate change on smallholder farmers, assessing indigenous climate change practices in smallholder farmers and assessing climate smart technologies being used by smallholder farmers in Hoima district. The study employed a case study research design. Sample size of 120 respondents was selected using purposive sampling and data collected using questionnaires, key informants and non-participant and analysed using statistical package for social scientist (SPSS version 20).

The study found out that smallholder farmers had coping practices or climate smart technologies such as, mulching (10.3%), agroforestry (0.0%), crop rotation (55.7%), intercropping (24.7%), fallowing (4.1%) and use of organic manure (5.2%).Climate smart technologies aims to sustainably increase agricultural production and increase resilience to climate change. It also addresses the challenges of how to transition to a climate smart agriculture. The study also revealed that the impacts of climate change among the smallholder farmers was crop failure (68.0%), increased poverty levels (26.8%), food scarcity/famine (0.0%) and increased animal/crop pest and disease incidences (5.2%). It was further found out that most farmers have embraced at least one adaptation strategy, which are mainly influenced by perceptions/attitude, level of awareness, access to credit, and size of cultivatable land among others. Furthermore, Indigenous knowledge was revealed as one of the unique adaptation strategies that was informally being applied by the farmers based on Early warning systems (Migratory birds, Massive collection of pollen and nectar by bees as a sign of rains, Reddish yellow sky and Shading off of tree leaves, as a sign of dry spells) and underscored its importance but acknowledged that it is however not well harnessed.

The study concludes that the implications of climate change are found to vary under various socio-economic scenarios and as such, the capacity to adapt is determined by level of awareness, access to credit, gender, and land ownership.
Proposals were made and these included; developing and implementing integrated natural resource management for harmonization of key conflicting policies, enhance opportunities for small scale irrigation and water harvesting, promote formation of local rural institutions and farmer groups, encourage transition to climate smart agriculture and improve the availability and quality of meteorological monitoring data.

CHAPTER ONE: GENERAL INTRODUCTION

1.0 Introduction

This study was about the adoption of climate smart technologies by selected smallholder farmers in Hoima district, in Kigorobya and Buseruka Sub counties. It explores the impacts of climate change, indigenous knowledge on climate change practices and climate change adaptation practices among smallholder farmers.

1.1Background

Global climate change is one of the most critical challenges facing the international community (Okonya *et al*., 2013). The world's climate is changing and will continue to change at rates projected to be unprecedented in recent human history (Adger *et al*., 2003). According to the Intergovernmental Panel on Climate Change (IPCC), global changes are manifested through rising temperatures, changing patterns of precipitation, and rising atmospheric carbon dioxide (Simotwo *et al.,* 2018). Climate related changes have significant impacts on ecosystems, societies and on individuals differently depending on their level of vulnerability; academic disciplines use the term 'vulnerability' referring to a condition in which human communities and/or their assets and livelihoods are susceptible to injury, loss, or disruption (Djoudi&Brockhaus 2011). Smallholder agro-ecosystem performances in the developing world, whose main economic contributions emanates from agriculture dominated by smallholder/subsistence farming with few if any purchased inputs with little surplus to sell have been found more susceptible to climate change (Simotwo *et al.,* 2018, Denton 2002, Marton 2007).Even among the smallholder agro-ecosystems, climate change affect people and communities differently depending on their adaptive capacity and resources (Djoudi&Brockhaus, 2011).

Climate change 'adaptation' according to UNDP (2007), is the adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects through changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.Adaptation to climate change and variability is widely acknowledged as a vital component of any policy response. Studies show that low input farming systems, such as subsistence agriculture in marginal areas is not only unsustainably depleting the natural resource base; it is also demonstrably ineffective at alleviating rural poverty (IPPC, 2007; Milder, Majanen&Scherr, 2011). Thus, without adaptation, climate change will push poor rural farmers on a razor's edge of survival, but with adaptation, vulnerability can largely be reduced (Adams *et al*., 1998; FAO, 2008).

In Uganda, weather-related events such as prolonged dry seasons, floods, storms, mudslides, extreme rainfall, and delayed/early rains have become more frequent and/or intense (Okonya *etal.*, 2013). Climate change therefore, tend to exacerbate existing inequalities, so smallholder farmers tend to face larger negative impacts (Annecken.d). As such, it is critical to examine climate adaptation practices as response efforts among smallholder farmers (Lambrou&Piana2006).

1.2 Problem statement

Uganda like most developing countries is significantly dependant on agriculture which is dominated by smallholder farmers who are said to be more vulnerable to climate change effects due to their low adaptability capacity (Adeleke *et al.*, 2010). Despite Uganda being vulnerable to rainfall variability and climate change shocks like drought and floods, micro-level studies on climate change adaptation strategies are limited (Okanya *et al.*, 2013).Most climate impact studies tend to look at the magnitude of vulnerability and ability to adapt in form of developed and developing countries or breaking it down to communities or societies

in a generic perspective without looking at specific climate change adaptation strategies (Djoudi&Brockhaus, 2011).

Bunyoro region like any other part of the country has equally been affected by climate change, there is, however, a scarcity of information on agricultural adaptation strategies embraced by the farmers in Mid-Western Uganda (Bashasha *et al.,* 2010).There is limited information on adoption of off-farm livelihood strategies and other adaptive mechanisms that farmers use to circumvent the welfare impact of climate change in Uganda. Hence, this study was designed to make a contribution towards bridging the gap by assessing farmer perceptions of climate change, evaluate existing coping mechanisms, and assess factors influencing the adoption among small-scale households in Hoima district.

1.3 Objectives of the study

1.3.1 Main Objective

To assess the adoption of climate smart technologies by selected smallholder farmers in Kigorobya and Buseruka Sub-counties in Hoima district.

1.3.2 Specific objectives

1. To evaluate the impacts of climate change on smallholder farmers in Hoima district
2. To assess indigenous climate change practices in smallholder farmers in Hoima district
3. To assess climate smart technologies being used by smallholder farmers in Hoima district, in Kigorobya and Buseruka Sub counties

1.4 Research Questions

1. What are the impacts of climate change on rural livelihoods?
2. What are the best climate smart technologies adopted in smallholder agro-system?
3. What are some of the indigenous climate change practices used by farmers?

1.5 Scope of the study

Geographical Scope

This study was carried out in Kigorobya and Buseruka Sub counties in Hoima district. The study mostly focused on climate change adaptation strategies in smallholder agro-system where people's experiences and perceptions on the various strategies of adapting to climate change aspects in selected villages of Kigorobya and Buseruka Sub counties were sought.

Hoima is one of the Districts of Uganda situated in the mid-western region, often referred to as Bunyoro region. The District boarders with the District of Bullisa in the North-east, Masindi in the East, Kakumiro and Kikuube in the South and Lake Albert in the North.

Buseruka Sub County is 65 kilometres from Hoima town, whereas Kigorobya Sub County is 35 kilometres from Hoima Town

Time scope

The period between the years 2006–2017 (Twenty years) provided the focus on which the study was to be conducted. The study aimed at investigating and assessing the vulnerability and adaptability among smallholder agro-systems. The choice of this time scope (2006-2017) was due to the fact that it is during this period that extreme climatic conditions were recorded. For instance, 2016 is on record with the highest temperatures in Uganda. However, the study was conducted for a period of nine months, starting from January 2018 all through September 2018.

1.6 Significance of the study

Uganda is still highly vulnerable to climate change (Thornton *et al*., 2006) and her smallholder farmers are generally poor. Vulnerability studies, particularly environmental based studies are relevant in providing grass root information on constraints that may possibly hinder climate change adaptation. This is useful for drafting sustainable policies geared towards improving adaptive capacities of smallholder farmers for overall growth of agricultural sector.

In terms of agricultural profitability analysis, the study on climate change adaptation is important because farmers will only use adaptation strategies on a larger scale only when they are convinced that they are the best bet for income generation. The benefits of adaptation can then be better exploited by all farmers without increasing costs for others since there are few resources to draw upon in times of crisis especially for the female headed households. Also knowledge of profitable climate change adaptation practices can provide a basis on which innovations may be built later for a given region.

A thorough analysis of impacts of adaptation to climate change will help guide smallholder farmers' choice of best adaptation practices in the study area, which if implemented will not only build resilience, but also improve on agricultural production that has adversely been affected by climate change. This will subsequently result into improved standards of living since improved production will mean food security and surplus production for selling.

1.7 Justification of the study

It is reported that there is a general lack of empirical understanding about how household in the Northern and Southern Albertine Rift landscapes of Uganda use the surrounding natural resources in the face of changing economic and social conditions (Twongyire *et al.,* 2017), yet this is critical for policy development, especially for designing sound agricultural and

forestry policies. Therefore, study findings on climate change vulnerability and adaptation among smallholder agricultural communities in Kigorobya and Buseruka in Hoima district proves critical for future planning for these landscapes and nationally.

The uncertainty about future trajectory of climate change is posing serious challenges on the nature of change and the accompanying consequences, preventing people at different levels from making critical decisions that are necessary to adapt. While a detailed knowledge of likely or potential future climate would be desirable, lack of it should not be an impediment to increasing the general resilience of societies to future environmental threats. In this regard, the study does not only allow the assessment of outcomes that facilitate policy consideration and decision making in the face of future uncertainty, it also builds the knowledge base to guide adaptation of agricultural systems. This will reduce the vulnerability of rural households and increase the opportunities for sustainable development.

The study further promotes the 15th Goal of the Sustainable Development Goals which calls on member states to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. The findings of this study will be useful in projecting the consequences of changes on the conservation of natural resources, and with appropriate action, contribute to sustainable management.

Agriculture is the backbone of Uganda's economy and the agricultural sector continues to be viewed as a vehicle through which economic growth and development can be achieved, as stipulated in the National Development Plan in the Uganda Vision 2040 with most agricultural production associated with smallholder farmers who account for over 85% of the total production whose livelihoods are embedded in complex agro-ecological systems and are dependent on natural resources like forests (Twongyire *et al.,* 2017). Therefore, this study

provides useful information to guide the planning for this important sector that can steer the country towards Uganda's Vision 2040.

1.8 Definition of Key Terms

Climate change: The study considers this to be a change in global or regional climate patterns attributed largely to the increased levels of atmospheric carbon dioxide (Below *et al.,* 2010).

Climate Variability: This is defined as variations in the mean state and other statistics of the climate on all temporal and spatial scales, beyond individual weather events. The term ''Climate Variability'' is often used to denote deviations of climatic statistics over a given period of time (e.g. a month, season or year) when compared to long-term statistics for the same calendar period (Mile *et al.*, 2000)

Vulnerability: According to Descheemaeker *et al.*, (2016), Vulnerability is referred to as the degree to which a system is susceptible to and unable to cope with adverse effects (in this particular case effects of climate change)

Climate change adaptation: The study adopts the International Panel on Climate Change (IPCC) definition of adaptation as adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects of impacts. This refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (IPCC 2001).

Indigenous Knowledge: This is considered to be the knowledge accumulated over generations of living in a particular environment (Egeru 2012).

1.9 Theoretical Framework

This study is informed by the capability theory (Sen, 1999, 2004; Nussbaum, 2003, 2011) and random utility maximization theory (McFadden, 1974; Cascetta, 2009).

Capability theory

The theory examines capacities necessary for people to lead functioning lives. A person's functioning reflects the collection of "beings" and "doings", and can be viewed as various outcomes a person may achieve (Goeme, 2010). The central argument of this theory is the need to judge just arrangements in distributive terms, and how they affect the ultimate well-being and functioning of people's lives. The central question about justice is what we are actually able to do and be it is not about commodities or the total/average GDP, but how they enable us to function (Nussbaum, 2011). A capability approach focuses on whether or not people possess capacities necessary to construct a fully functioning life. Such capacities are supported by among others, natural systems that directly depend on a stable climate system.

Capablities approach provides concepts that can encompass the current framing of climate justice, but in a way that is more applicable to the development of adaptation policy (Schlosberg, 2011). Since this approach addresses the basic requirements that are necessary for human life to function and flourish; it is important to align adaptation policies with climate justice that protects the basic functioning of human communities, including the environment.

Changes in climate will affect what individuals are able to do with the resources that they have. If climate change impedes agricultural practices, or/and undermines local infrastructure, then functioning will be limited. In that case, climate change is a barrier to functioning lives (Schlosberg, 2009). Similarly, potential mental health impacts, such as the increased stress of those made climate refugees, and the overall anxiety of rapid climate change, could be seen as a barrier to capability of emotional health (Nussbaum, 2011).

Crucially, a capabilities-based approach to adaptation is not a top-down, expert-driven affair. Rather, communities need to be thoroughly involved in defining their own vulnerabilities and designing just adaptation policies that are planned to shield them from climate change that threatens their ability to function (Schlosberg, 2009; Ribot, 2010). Thus the approach offers a way of analyzing the particular needs of communities, of identifying gaps which hinder people to adapt to climate change, of directing adaptation policy toward preserving or rebuilding the specific capabilities under threat from climate change, and of measuring the success of implemented adaptation policies.

The Random Utility Maximization Theory

The decision to use any adaptation option falls under the frame-work of random utility theory. According to this framework, people choose what they prefer, and where they do not is influenced by random factors (McFadden, 1973). Thus, the utility of a choice is comprised of deterministic and an error components. The error component is independent of the deterministic part and follows a predetermined distribution. This shows that it is not usually possible to predict with certainty the alternative that the decision-maker will select. However, it is possible to express probability that the perceived utility associated with a particular option is greater than other available alternatives (Luce, 1959; Cascetta, 2009).

The utility *U* that individual *i* gains from the consumption of a good *j* is made up of an observable deterministic component *V* (the utility function) and a random component *e*, and can therefore be defined as follows:

$Uij = VtJ + Eij$

According to Cascetta (2009), we assume that utility *U* depends on choices made from some set of *j* adaptation options. The individual is assumed to have a utility function of the form:

$Ull = V(Xj, Z\text{i})$

A rational farmer who seeks to maximize the present value of benefits of production over a specified period of time must choose among a set of *j* adaptation options. The farmer *i* will use *j* adaptation option if the perceived benefit from that option is greater than the utility from other option *k if Uj>Uk.* Utility derived from any adaptation option is assumed to depend on the attributes of the adaptation option itself *Xj* and the socio-economic characteristics of the farmer *Zt* (Cascetta, 2009). However, a farmer may not choose what seems to be the preferred adaptation option. To explain such variations in choice, a random element, *e* is included as a component of utility function. Equation 3.2 can then be re-written as:

Uii = V(Xj,Zi) + s(Xj.Z,)

The probability that farmer *i* will choose adaptation option *j* among the set of adaptation options *k* could be defined as follows:

Pr[i|C5] = *Pr[Uj>Uk],* V) e *CS*

=*Pr[(Vj + £j) > (Vk* + £k)]

=*Pr[(Vj-Vk)* >£]

Where CS is the complete choice set of adaptation option. In order to estimate equation 3.4, assumptions must be made over the distributions of the error terms. A typical assumption is that the errors are Gumbel-distributed and independently and identically distributed (McFadden, 1973).

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This literature provides an opportunity to understand the different opinions voiced by various authors in relation to my study objectives. The review therefore sought to provide an in-depth critical evaluation of existing literature and emerging issues pertinent to this study. It followed the same progressive structure of the dissertation.

2.1 Climate Change

Climate change will have significant impact on the livelihoods of the rural poor in developing countries. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicts that climate change is likely to have a significant effect on agricultural production in many African countries. Projected reductions in yield in some African countries could be as much as 50% by 2020, and net crop revenue could fall by 90% by 2100 which is a serious threat to food security and to the achievement of major developmental goals (Below et-al 2010). With increased intensity and frequency of weather and climate change related events, climate change has therefore become an integral part of development planning outcomes and threaten the resilience of livelihoods and ecosystems. Climate change according to Below et al (2010) will have significant impact on the livelihood of the rural poor in developing countries.

But for the East African region, it has been projected that under medium emission, annual temperatures will increase by 3.2^0C and rainfall by about 7% towards the end of the century through studies from a set of global models. The region will be warmer by bout 1^0C by 2030 and 2^0C by 2050 with slightly higher rainfall especially during September to February, increase in frequency of both extreme wet and dry seasons and rainfall variability across seasons is expected to increase (Rao 2013).

The four of East African economies of Uganda, Ethiopia, Kenya and Tanzania are all agriculture-based with variations in terms of the sector's contribution to GDP. In Ethiopia and Tanzania, agriculture remains the contributor to the GDP, contributing 47 percent and 43 percent respectively. In Uganda and Kenya, however, the rapid development of the service sector with s growth rate of about 9.5 percent, has outpaced agriculture, contributing 45 percent and 60 percent of the GDP respectively, far above agriculture's contribution of 30 and 34 percent. Nevertheless, agriculture still accounts for about 75% of the labour force in all these East African countries, understanding the importance of the sector in job creation and poverty reduction across countries (Adeleke *et al.,* 2010).

The debate on climate change has recently shifted from high level advocacy on "the need to act" to regional, country and community level responses on "how to adapt". African countries are said to be more at risk from climate change effects because of a number of factors including limited skills and equipment for disaster management, limited financial resources, weak institutional capacity and heavy dependence on rain-fed agriculture, climate change threatens to intensify development challenges already confronting the Sub-Saharan region including food security (Nabikolo *et al.,* 2012). It is therefore argued that climate change represent the largest challenge humankind has ever faced with frightening predicted and observable impacts of climate change (Mac Gregor 2010). The scientific consensus about these projections, expressed by the IPCC among others, has shifted the debate away from the questions of whether or not anthropogenic climate change is happening toward debates about what is to be done by whom, when, and how (Ibid).

In Uganda, climate change has been reported as having a significant impact on rural livelihoods, with farmers describing changes in variability and seasonality; the interconnected nature of livelihoods means that climate change can impact both directly and indirectly on many different aspects, exacerbating existing vulnerabilities in health, water availability and

agricultural production (Osbarhr *et al.*, 2010). For example, there is evidence for increased malaria in some regions, farmers claim increasingly unpredictable weather which has led to poor yields, a reduction in crop varieties and pastures, poor animal health, rangeland related conflicts, greater expense and labour, food insecurity and reduced incomes leading to poverty and with only 0.1% of land irrigated, changes in rainfall and temperature greatly impact the rain fed agricultural sector as well as the ability to achieve broader development objectives in Uganda (Ibid)

2.2 Adaptation and vulnerability to climate change

The climate is changing and mitigation efforts to reduce the sources or enhance the sinks of greenhouse gases will take time; adaptation is therefore critical and of concern in developing countries, particularly in Africa where vulnerability is high because ability to adapt is low (Hassan & Nhemachena, 2008).

Adaptation is one of the policy options for reducing the negative impacts of climate change (Adger,2003; Deressa et al,2009); adaptation practices reduce loss due to climate change, or increases gains. The IPCC (2001), defines adaptation to climate change as an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities. Adaptation can involve both building adaptive capacity thereby increasing the ability of individuals, groups, or organisations to adapt to changes, and implementing adaptation decisions, i.e. transforming that capacity into action. Both dimensions of adaptation can be implemented in preparation for in response to impacts generated by a changing climate. In this regard, climate change adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including climate variability, extreme weather conditions such as droughts and floods, and volatile short-term changes in local and large-scale markets

(Hassan and Nhemachena 2008). As such, farmers can reduce the potential damage by making tactical responses to these changes (Ibid) and any preparedness towards a potentially adverse situation, including climate change, has been shown to correspond to perceptions and awareness levels among the affected individuals and/or groups. Thus, smallholders ought to change their perception to match the rate of climate change (Simotwo *et al.,* 2018).

Furthermore, adaptation to environmental change is a norm rather than exception. Throughout human history, societies have adapted to natural climate and environmental changes by altering settlement and agricultural patterns and other facets of their economies and lifestyles (McCarl *et al.,* 2001; Easterling, Hurd & Smith, 2004; Burton *et al.,* 2006; Adger *et al.,* 2007; Heltberg, Siegel & Jorgensen, 2008). Thus, most societies are reasonably adaptable to changes in average conditions, particularly if they are gradual (Burton *et al.,* 2006). However, communities are more vulnerable and less adaptable to human-induced climate change.

Adaptation to climate change has become one of the focal points of current development discourse, particularly agriculture. As a result, it has found expression as a response strategy in the UNFCCC and the resulting Kyoto Protocol in 1997. Article 4.1 (f) of the UNFCCC commit parties to:

> *Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, with a view to minimizing adverse effects on the economy, to mitigate or adapt to climate change.*

The rise of climate change adaptations to political currency is two-fold: developing countries are extremely vulnerable to climate change impacts, because a large proportion of their economies is climate sensitive, and they have less adaptive capacity (IPCC, 2007).

Socio-economic adaptation to climate change

This thesis is premised on the concept of adaptation of people and their livelihoods to climate change. Adaptations are adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts (IPCC, 2001; Smit & Olga, 2001). Thus, adaptation can reduce adverse impacts of climate on human health and well-being, and increase the capacity to take advantage of the opportunities (IPCC, 2007; Smit & Olga, 2001). Regarding human dimensions, adaptation to climate change entails adjustments in socio-economic arrangements that reduce the vulnerability of households, communities, groups, sectors, regions, or countries to changes in the climate system (Smith, 1997; Smit & Wandel, 2006; Fussel, 2007).

The goal of climate change adaptation is to build the resilience of communities towards different kinds of changes in their environment. Resilience is the capacity to maintain competent functioning in the face of major life stressors (Adger, 2000). Thus, it demonstrates the capacity of human systems or entities to bend without breaking in the face of disturbance and, once bent, to spring back to its pre-disturbance steady state (Easterling *et al.,* 2004). Unlike natural ecosystems, human systems have the capacity of foreseeing and adapting to possible environmental changes (Adger, 2000; Folke *et al.,* 2002; Easterling *et al*., 2004). When a social or ecological entity loses resilience, it becomes more vulnerable to changes that previously could be absorbed and adapted to (Folke *et al*., 2002). Sustainability of humans on earth is linked to resilient socio-ecological systems, which is influenced by human capital and institutional arrangements (O'Brien *et al*., 2012). The terms "coping" and

"adaptation" are often used interchangeably to reflect strategies for adjustments to changing climatic and environmental conditions (O'Brien *et al*., 2012). However, the two are associated with different time scales and represent different processes (Eriksen & Kelly, 2007). Whereas, coping is a short term reactive response to climate variability, adaptation is associated with longer time scales and points at adjustments as fundamental changes of the systems practices, processes or structures to changes in mean conditions (Ibid). With adaptations, new coping range is established (Smit & Wandel, 2006).

Nonetheless, coping strategies may become adaptive strategies when people are forced to use them over a run of bad years and across seasons rather than just at the worst time of the year (Anderson *et al*., 2010). Besides, the way households cope with crises either may enhance or constrain the future coping strategies, as well as their possibilities to adapt in the longer term (O'Brien *et al*., 2012).

Adaptation types have been differentiated according to numerous attributes. Commonly used distinctions are purposefulness and timing (Smit & Olga, 2001). The IPCC (2007) recognizes three types of adaptation: First, autonomous, or spontaneous adaptations are considered to be those that take place - invariably in unconscious and reactive response - after initial impacts are manifested to climatic stimuli as a matter of course, without the intervention of public policy. Second, anticipatory, or proactive adaptation takes place before the impacts of climate change are apparent. Third, planned adaptation is based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state. However, due to institutional constraints, planned adaptation has been slow in forthcoming in many developing countries, and populations are most vulnerable to disrupted agricultural production (Maddison, 2006).

Whereas planned adaptations are intervention strategies, autonomous adaptations occur naturally without interventions by public agencies (Smith *et al,* 1996). Thus defined, autonomous and planned adaptations largely correspond with private and public adaptation, respectively. However, it is the autonomous adaptation that forms a baseline against which the need for planned anticipatory adaptation can be evaluated (Smit & Olga, 2001).

2.3 Vulnerability to climate change

Vulnerability can be defined from different perspectives, depending on the stakeholders involved (Adger, 2006; Heltberg *et al,* 2008). Vulnerability to climate change does not exist in isolation from the wider political economy of resource use. It is often driven by inadvertent or deliberate human action that reinforces self-interest and the distribution of power, besides interacting with biophysical systems (Ribot, 2010).

The policy context in which climate risks are dealt with and adapted to is informed by two polarized interpretations of vulnerability, namely, risk-hazard and social constructivist frameworks (Kelly & Adger, 2000; Adger 2006; Fiissel & Klein 2006; O'Brien *et al*., 2007). The risk-hazard model tends to evaluate the multiple outcomes of a single climate event, whereas the social constructivist framework characterizes the multiple causes of single outcomes (Adger, 2006).

The risk-hazard approach sees vulnerability as a linear result of climate change impacts and aims at reducing the projected impacts through technological 'fixes'(Eriksen & Kelly, 2004; Fussel, 2007; O'Brien *et al*, 2007). On the other hand, the social constructivist framework considers vulnerability as an attribute of social and ecological systems that are generated by multiple factors and processes (Eriksen & Kelly, 2004). Unlike the risk-hazard model that places the burden of explanation of vulnerability within the biophysical system, the social

constructivist framework places the same burden within the social system (Adger, 2006; Ribot, 2010).

Although both frameworks of vulnerability are useful for policy response to environmental change, an integrative framework is more useful for planned adaptation to climate change. This is because it links the two approaches and views vulnerability as depending on both biophysical and human factors. Besides, vulnerability is portrayed as having "an external dimension, which is represented by the 'exposure' of a system to climate variations, as well as an internal dimension, which comprises its 'sensitivity and its adaptive capacity" to these stressors' (Fiissel & Klein, 2006).

The extent to which natural and socio-economic systems are at risk to anthropogenic climate change depends not only on the degree of exposure, but also on the sensitivity of a system to the impact and its adaptive capacity (Smit & Olga, 2001; IPCC, 2001, 2007). The exposure of a system refers to the degree of a perturbation, stress, hazard or shock, which causes a significant transformation or changes to a system, and can happen suddenly or over a longer period of time (Gallopin, 2006). On the other hand, sensitivity is the degree to which a system is affected or modified by climate change without accounting for adaptation (Easterling *et al*., 2004. The impacts may be harmful or beneficial as well as direct or indirect (Gallopin, 2006; IPCC, 2007).

The adaptive capacity relates to the system potential or capacity to react to the impacts or transformations related to climate change, moderate potential damages, take advantage of opportunities, or cope with the consequences. It demonstrates the system's ability to accommodate or deal with exposure, and expand a range of options with which it can prepare for and undertake adaptation (Adger, 2006; Gallopin, 2006; IPCC, 2007; O'Brien *et al*., 2012).

The adaptive capacity of households and communities is determined by their socio-economic characteristics such as access to financial, technological and information resources, the institutional architecture within which adaptations occur, human capital, political influence, and kinship networks (Easterling *et al*., 2004; Smit &Wandel, 2006; Heltberg *et al*., 2008).

2.4 Impacts of climate change on agricultural production

The projections of future climate change are uncertain especially in relation to scenarios of future rainfall, floods and droughts. However, temperature projections are generally more reliable. A warming throughout sub-Saharan Africa is projected to be larger than the global annual average (IPCC, 2007). As regards rainfall, some model predictions indicate that East Africa region is going to have increased rainfall events (IPCC, 2007; SEI, 2009; Seitz & Nyangena, 2009), while other recent research suggests that local circulation will result in depressed precipitation instead (Funk *et al,* 2008). Nonetheless, the climate is changing already and a striking consensus is that the future climate is unlikely to be the same as at present. Thus there is need to apply precautionary principle on the grounds that the costs of not acting are likely to be incalculably high.

Spatial and temporal variation of precipitation and increased temperatures are the main climate change related drivers, which impact agricultural production (ODI, 2009). Increased temperature levels will cause additional soil moisture deficits, crop damage and crop diseases; unpredictable and more intense rainfall; and higher frequency and severity of extreme climatic events (Boruru, Ogara & Oguge, 2011). Similarly, the drivers of climate change have the potential of altering plant growth and harvestable yield through carbon dioxide fertilization effects (UNDP 2012). Free Air Carbon Enrichment (FACE) experiments indicate productivity increases in a range of 15 - 25% for C3 crops (wheat, rice and soya beans) and 5 - 10% for C4 crops (maize, sorghum and sugarcane). Higher levels of carbon

dioxide also improve water use efficiency of both C3 and C4 plants (Lotze-Campen & Schellnhuber, 2009). However, there is uncertainty about the magnitude of the positive effects of enhanced carbon dioxide concentration.

Climate change will interlock with people's life-worlds differently for different reasons. The geography of a people's location relative to other people may position them more acutely in harm's way when climate change ramifications unfold (Boruru *et al.,* 2011). In mid to high latitude regions, moderate local increases in temperature can have small beneficial impacts on crop yields, while in low latitude regions, such moderate temperature increases are likely to have negative yield effects (Iglesias, 2006; Aydinalp & Cresser, 2008; IAASTD, 2009). This will significantly increase yield variability in many regions of the world, and result into polarization of effects with substantial increases in prices and risk of hunger amongst poorer nations (Iglesias, 2006; UNDP, 2012). However, through advance preparation and careful management of agricultural systems, these risks could be substantially reduced. Recent studies show that for each 1°C rise in average temperature, dry land farm profits in Africa will drop by nearly 10% (FAO, 2008). Similarly, yields from rain-fed crops could be halved by 2020, and net revenue from crops could fall by 90% by 2100 in some countries in Africa (UNFCCC, 2007).

Extreme climatic events of drought and floods are threat to agricultural system and could bring about both chronic and transitory food insecurity. This is because many crops have annual cycles and yields that fluctuate with climate variability, particularly rainfall and temperature (FAO, 2008). As a consequence of climate change, rural areas that depend on rain fed agriculture will become more vulnerable to food insecurity

2.5 Agricultural adaptation

2.5.0 Introduction

Agricultural adaptation is a vital policy response that will shape the future severity of climate change impacts on food security. Studies indicate that adaptation can lessen the yield losses that might result from climate change, or improve yields where climate change is beneficial (Adams *et al.*, 1998). Although relatively inexpensive adaptation options such as crop diversification and altering the timing of operations, may moderate adverse impacts, the biggest benefits will likely result from more costly measures including institutional strengthening and technological developments (Easterling *et al*., 2004; Smit &Wandel, 2006). These adaptation measures, alongside other competing interests, will require substantial resource allocation by farmers, national and county governments, scientists and development partners.

2.5.1 Levels of Agricultural Adaptation

Adaptation occurs at two main levels: the farm-level and macro-level (Kandlinkar & Risbey, 2000). While the farm level is focused on micro analysis of farmer decision making, the macro level deals with national agricultural production and its relationships with domestic and international policy (Ibid). Farm-level decisions are short-term and made in response to seasonal climatic shifts, and therefore, determined by socioeconomic variables such as household characteristics, household resource endowments, access to information and availability of formal institutions. Contrastingly, macro-level analysis is long-term strategic national decisions and policies made in response to long-term changes in climatic and market conditions.

2.5.2 Determinants of Adoption

The literature on adoption identifies a range of household and farm characteristics, institutional factors, and local climatic and agro-ecological conditions as the key determinants of the speed of adoption (Maddison, 2006; Gbetibouo, 2009). The adaptation options taken by most farmers are not only those that build adaptive capacity and enhance climate resilience, but also those that will address conservation of natural and environmental resources (Seitz & Nyangena, 2009).

The household characteristics which have significant impact on adoption decisions include age, education level, gender of the head of the household, family size, years of farming experience, and wealth. The age of a farmer may positively or negatively influence the decision to adopt new technologies (Gbegeh & Akubuilo, 2012). Older farmers have more experience in farming and are better able to assess the characteristics of modem technology than younger farmers, and hence a higher probability of adopting the practice. On the other hand, older farmers are more risk-averse and less likely to be flexible than younger farmers and thus have a lesser likelihood of adopting new technologies (Adesina & Forson, 1995). Younger farmers are likely to incur lower switching costs in implementing new farming practices since they have limited experience and therefore, adjustment costs involved in adopting new technologies may be lower for them (Marenya & Barrett, 2007).

Level of education or awareness

Education and human capital endowments are often assumed to increase the likelihood of embracing new technologies. This is because they enhance the ability of farmers to perceive climate change (Nkonya *et al.*, 2008). Similarly, education enables households to access and conceptualize information relevant to making innovative decisions (Adesina & Forson 1995; Daberkow & McBride 2003; Shiferaw, Okello & Reddy, 2009; Ochieng', Owuor & Bebe, 2012, Gbegeh & Akubuilo, 2012). However, higher educational attainment can present a

constraint to adoption because it offers alternative livelihood strategies, which may compete with agricultural production.

Gender

The effect of gender of the household head on adoption decisions is location-specific (Gbetibouo, 2009). In many parts of Africa, women are often deprived of property rights due to social barriers (Gbegeh & Akubuilo, 2012). Consequently, they have fewer capabilities and resources than men (Quisumbing *et al*., 1995; De Groote & Coulibaly, 1998; Marenya & Barrett, 2002; OECD, 2009; Gbegeh & Akubuilo, 2012). This often undermines their capacity to embrace labour-intensive agricultural innovations. However, female-headed households are more likely to take up climate change adaptation measures (Nhemachena & Hassan, 2007; Gbetibouo, 2009). The possible reason for this observation is that in most rural smallholder farming communities in Africa, more women than men live in rural areas where much of the agricultural work is done. In this respect, women have more farming experience and information on various management practices and how to change them, based on available information on climatic conditions and other factors such as markets and food needs of the households (Nhemachena & Hassan, 2007).

Asset endowments and wealth have a significant influence on the ability of smallholder farmers to adopt certain technological practices (Reardon &Vosti, 1995; Nkonya *et al*., 2008; Gbetibouo, 2009). Households with higher income and greater assets are less risk averse than lower income households, and therefore in better position to adopt new farming technologies (Shiferaw & Holden, 1998).

Size of household and farm

The influence of household size on the decision to adapt is uncertain. Household size as a proxy to labour availability may influence the adoption of a new technology positively as its availability reduces the labour constraints (Marenya & Barrett, 2007; Teklewold *et al*.,

2006). Given that the bulk of labour for most farm operations in sub-Saharan Africa is provided by the family rather than hired, lack of adequate family labour accompanied by inability to hire labour can seriously constrain adoption practices (Nkonya *et al*., 2008). Nonetheless, households with many family members may be forced to divert part of the labour force to off-farm activities in an attempt to earn income to ease the consumption burden imposed by a large family size (Tizale, 2007; Gbetibouo, 2009).

The farm characteristics that could influence the adoption decisions include farm size and soil fertility. Farm size influences both the access to information and the adoption decisions. More crop acreage is likely to enhance the information exposure to site-specific crop management technologies because these technologies would likely be marketed to larger farms (Marenya & Barrett, 2007; Daberkow & McBride, 2003). Given the uncertainty and the fixed transaction and information costs associated with innovation, there may be a critical lower limit on farm size that prevents smaller farms from adapting (Daberkow & McBride, 2003; Gbetibouo, 2009; Gbegeh & Akubuilo, 2012). Thus, large mechanized farms will probably be the first to adapt to climate change.

Institutional factors

Institutional factors that influence adoption of new technologies includes access to credit, information provision, off-farm employment, and land tenure. Institutional strengthening via access to formal and informal institutions and meteorological capability increases the likelihood of uptake of adaptation techniques. Households with access to formal agricultural extension, farmer - to - farmer extension and information about future climate change are more likely to adjust their farming practices in response to climate change (Smit *et al.,* 2001; Mariara & Karanja 2007; Yesuf *et al.,* 2008; Nkonya *et al*., 2008). In addition, farmers with access to extension services are likely to perceive changes in the climate because they have information about climate and weather changes (Gbetibouo, 2009). However, certain

information sources can be more effective “change agents” than others and various information sources can influence the probability of adoption differently (McBride & Daberkow, 2003). Similarly, different sources of information become influential during different stages of adoption process. The mass media for instance, are important in the early awareness stage, while interpersonal information sources such as extension officers and other farmers are critical in transferring more technical and adoption-promoting information (Ibid). Although technical information from extension services is shown to be most important to the potential adopter, the extension-farmer linkages are extremely weak in some parts of Sub-Saharan Africa and most agricultural information is obtained via farmer-farmer contacts (Adesina & Forson, 1995). This suggests that farmers are also important as sources of technology information and agents of technology transfer. Studies also reveal that adoption technologies flow through social networks, and do not necessarily spread because of geographical proximity (Maddison, 2006). Thus future extension should engage farmer cooperatives in research process and on-farm trials for a variety of evaluation and demonstrations. The trained farmers will then be able diffuse the adoption technologies since heterogeneity of farm situation invariably makes it difficult to provide government extension (Pannell, 1999).

Accessibility to credit

Studies have shown that under conditions of imperfect credit, smallholder farmers and resource users will adopt certain conservation practices (Reardon &Vosti 1995; Gbetibouo, 2009). This is because the adoption of new technologies requires borrowed or owned capital. Thus lack of borrowing capacity may hamper any efforts to embrace adaptation measures that require heavy investment upfront such as irrigation, terracing, tree planting and fertilizer use.

The other institutional factor conditioning the adoption of adaptation technologies mainly relate to the prevailing system of property rights (Gbetibouo, 2009; Shiferaw, Okello &

Reddy, 2009). Tenure security can contribute to adoption of technologies linked to land such as irrigation equipment or soil conservation practices. Farmers lack economic incentives to invest their time or money if they cannot capture the full benefits of their investments (Ibid). This condition may prevail when they have insecure rights to land or when the natural resource is governed by open access property regime.

2.6 Climate Smart-Agriculture

The nexus between agriculture and climate change is real and potentially deadly. On one hand, the agricultural value chain, and land use change, including deforestation account for 30% of the total global GHG emissions; while on the other hand, the adverse impacts of climate change are leading to land degradation, and food insecurity (IPCC, 2007; Celso *et al.*, 2012). And yet, agriculture has the potential to be part of the solution through integrated approaches of food security, adaptation and mitigation (World Bank, 2011, 2012).

In Low Income Countries, agriculture accounts for most land use, and thus the single most influence on environmental quality. Similarly, agriculture remains the principal livelihood of the rural poor. Yet patterns of rural population growth and agricultural expansion and intensification pose serious challenges to achieving both environmental improvements and rural poverty reduction (Scherr, 2000).

Livelihood security requires more resilient production systems. Similarly, more productive and resilient agriculture requires management of natural and environmental resources (FAO, 2010). Transiting to such systems could generate significant mitigation benefits (FAO, 2010; World Bank, 2011). Climate-smart agriculture seeks to increase productivity in an environmentally and socially sustainable way, to strengthen farmers' resilience to climate change, and to reduce agriculture's contribution to climate change by reducing greenhouse gas emissions and increasing soil carbon sequestration (FAO, 2010; World Bank, 2011).

Climate-smart measures include proven techniques - such as mulching, intercropping, integrated pest and disease management, conservation agriculture, crop rotation, agro forestry, integrated crop-livestock management, aquaculture, improved water management, better weather forecasting for farmers - and innovative practices, such as early warning systems (FAO, 2010; World Bank, 2011; 2012). It also entails embracing new technologies - such as diversifying genetic traits of crops to help farmers edge against an uncertain climate - and creating an enabling policy environment for adaptation (World Bank, 2011). In the absence of climate-smart agriculture, marginal areas may become less suited for arable farming as a result of land degradation through deforestation, soil erosion, repetitive tillage and overgrazing (World Bank, 2012).

Climate-smart agriculture is location-and production system-specific. Thus, its precise nature is influenced by local factors including the climate, types of crops grown and livestock reared, available technologies and knowledge and skills of individual farmers (FAO, 2010). However, there is recognition that climate-smart efforts must have at their heart smallholder farmer who is key to change across the entire agricultural system. Thus, policy-makers have continued to explore carbon finance as a lever to promote sustainable agricultural practices that have many other direct benefits for smallholder farmers and the environment.

Yet, a number of serious concerns remain unaddressed. Soil carbon sequestration prescribes a package of "best" management practices that score highest on sequestration rates. This might undermine farmers' dynamic and diverse adaptation strategies (Celso *et al*, 2012). Second, the expansion of soil carbon markets encourages private actors to extend their control over land without taking into account local land tenure arrangements, and often at the expense of smallholder and marginal farmers who do not have equal negotiating power compared to large landowners (Ibid)

Third, climate-smart agriculture is premised on a non-existent soil carbon markets (FAO, 2008). The major loophole in the packaging of carbon trading within climate-smart agriculture is the scientific uncertainties about the quantification and verification of soil carbon (Celso *et al,*2012)

2.7 Gaps in Literature Review

A substantial body of literature addresses possible impacts of climate change on agriculture. Most of these observations indicate that farmers can overcome the adverse impact of climate change by implementing adaptation measures (Adams *et al,* 1998; Yusuf *et al,* 2008; Matui, 2009). Even when such studies emphasize adjustment of agricultural practices to changing climate in semi-arid environments, they rarely identify location-and production system-specific farm-level adaptation strategies.

Much of the literature review on agricultural adaptation to climate change has drawn attention to a range of factors affecting the speed of adoption among small-scale households. A vast number of such studies identify household and farm characteristics and institutional factors as the key determinants of adoption (Adesina & Forson, 1995; Maddison, 2006; Marenya & Barrett, 2007; Nkonya *et al.,* 2008; Shiferaw *et al.,* 2009; Gbetibouo, 2009; Ochieng *et al.*, 2012; Gbegeh & Akubuilo, 2012). However, there is a paucity of information on the process of adaptation decision making among farmers. Identifying how and when to adapt agriculture to climate change remains far from clear. Moreover, the adoption literature examines factors influencing uptake of soil management practices in high potential agricultural areas (Tizale, 2007; Marenya & Barrett, 2007; Adolwa *et al*., 2012). However, there is limited information on adoption of off-farm livelihood strategies and other adaptive mechanisms that farmers use to circumvent the welfare impact of climate change in Uganda. Hence, this study was designed to make a contribution towards bridging the gap.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents a methodological framework that guided the researcher in carrying out the study on gender influence on climate change adaptation in smallholder agro-system in Kigorobya and Buseruka Sub-counties in Hoima district. It provides the study design, describes the study area and population composition. Provided also is a description of the methods and tools that was used to collect data.

3.1 Research design

This study was conducted through a 'case study design' to evaluate climate change vulnerability adaptation practices in smallholder agro-ecosystem in Hoima district. A case study research design is an intensive, descriptive, exploratory analysis of a single entity; applied purposively to study a single entity in-depth to gain insight into the larger cases, and to describe and explain rather than predict a phenomenon. This study design was selected for this study because it will use a smaller but representative sample for an in-depth analysis.

3.2 Area of Study

The study was conducted in Kigorobya and Buseruka Sub-Counties in Hoima district, in mid-western Uganda. Two parishes from each Sub-County were selected, that is, Nyakabingo and Kabaale parishes from Buseruka Sub-county and Kapaapi and Kibiro parishes from Kigorobya Sub-County. One village from each parish was selected and for this case, Waaki and Kapaapi One villages from Kapaapi and Kibiro parish respectively, and Kyapoloni and Rwamutonga villages from Kabaale and Nyakabingo respectively.

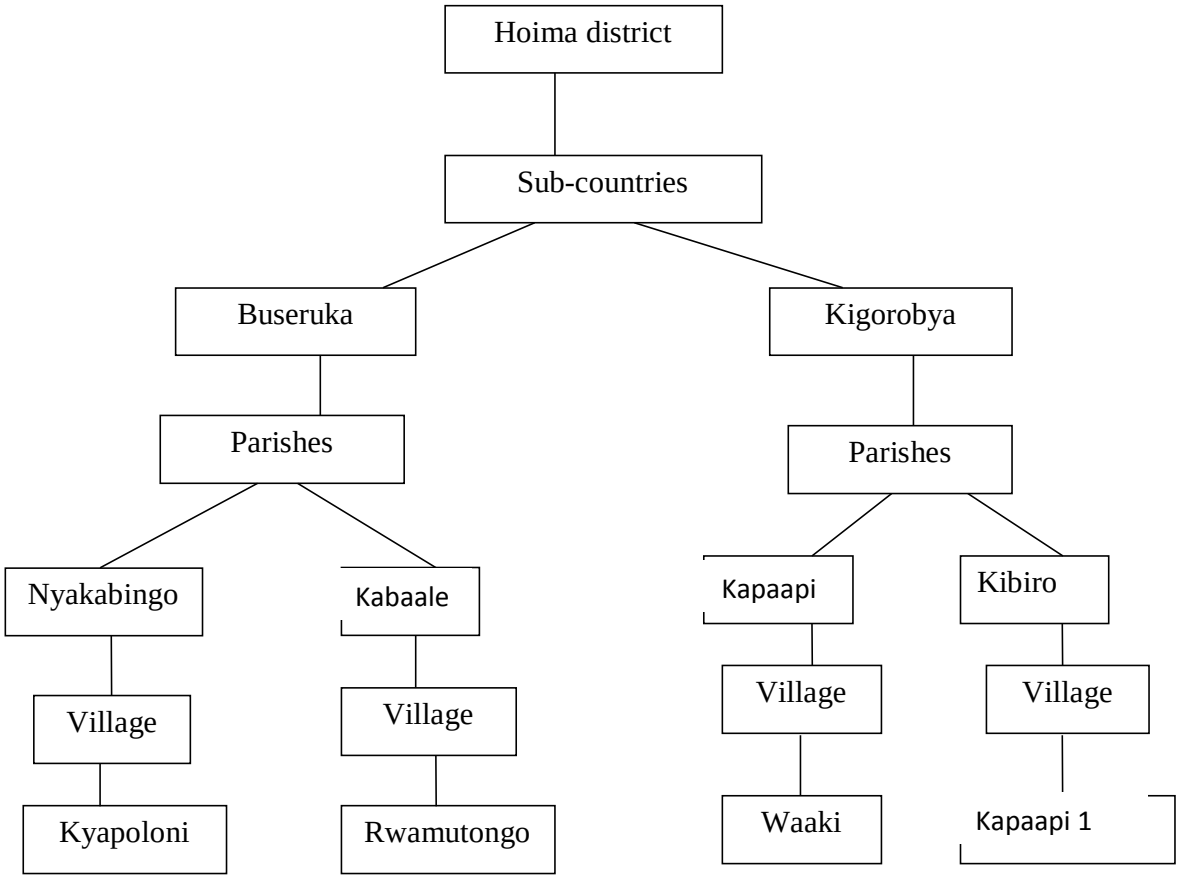

Figure 1: Illustration of sampling procedure of study sites

The region was purposively selected owing to its fragility and sensitivity to climate variability. It is an Albertine catchment and at the same time a cattle corridor with generally flat terrain, traversed by numerous swamps and wetlands. The district receives a rainfall pattern with totals ranging from about 800mm in the Lake Albert flat rising rapidly the further away East above the Escarpment to between 1250-1500mm per annum before tapering off to 1000mm in the Eastern border areas of the district (HDLG 2015). However, the rainfall pattern has become more erratic and less predictable. It is distributed between two seasons of March to July and September to November. Late November to late February or early March is traditionally the long dry season, and mid-June to late July is the short one; but this has become variable with frequent dry spells causing famine (MWLE 2007). The farming

system is predominantly annual cropping and small-scale farming making it more vulnerable to impacts of climate change.

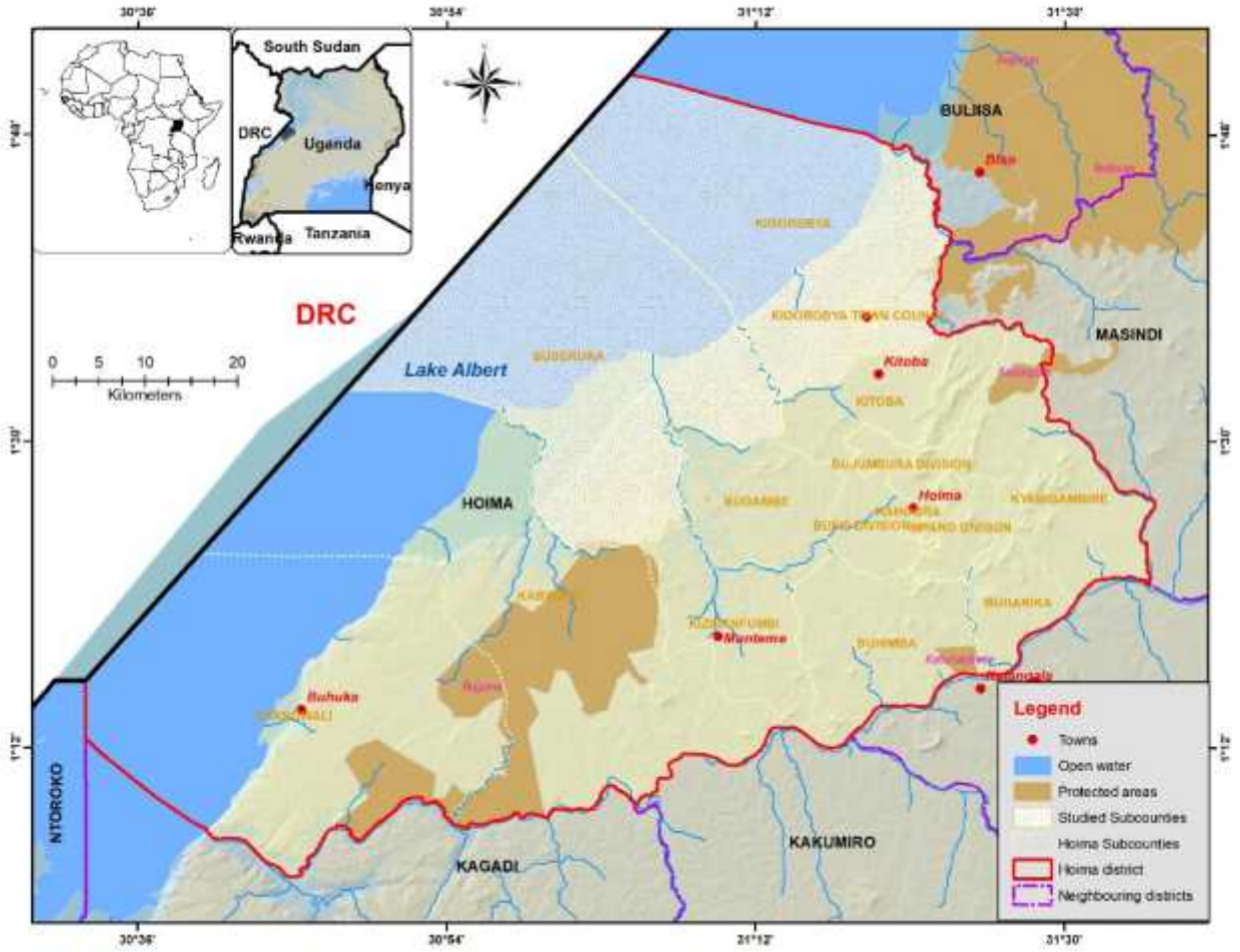

Figure 2: Location of Buseruka and Kigorobya Sub-Counties in Hoima district, Mid-Western Uganda

3.3 Study Population

In order to come up with reliable data, the study targeted two categories of respondents. That is; 120 Household respondents from selected villages from Kigorobya and Buseruka Sub-Counties were subjected to a structured questionnaire and FGDs. District, Sub-County, and village officials like village LC1s considered to have reasonable level of knowledge on the themes under investigation were interviewed as Key Informants (16). These included District Forest Officers, District Environment Officers, District Agriculture Officer, District Natural

Resource Officers, District and Sub-County Agricultural Extension Officers, Relevant governmental organisations like NARO, Operation Wealth Creation among others.

3.4 Sampling Procedure

Purposive sampling was applied in selecting 16 key informants for Key Informant Interviews and individuals who participated in Focus Group Discussions. The selection criterion for Key informant interviews was based on level of knowledge on the themes under investigation.

3.4.1 Sample Size

A total of 120 Household respondents and 16 key informants were interviewed. Two villages from each of the two sub-counties was selected based on occurrence of climate change impacts on smallholder agro-ecosystem and households were randomly selected. Selection of parishes and villages (with reference to the ones suggested in the study area above) to be surveyed were guided by knowledge of technical district officers. The sample size of households was determined by the number of households in each village. A margin error of 5% and confidence interval of 95% was considered to derive on the sample size using the Slovin's formular below.

$n=N/\ 1+N(e)^2$, Where n=Number of sample, N =Total population and e=Error tolerance (level)

From the list of 171 households of Kigorobya and Buseruka, we assume the error (e) to be 0.05 so that,

$$n = \frac{171}{1 + 171(0.05)^2} = \frac{171}{1 + 171(0.0025)} = \frac{171}{1 + 0.425} = \frac{171}{1.425} = 120 \text{ respondents.}$$

3.4.2 Sampling techniques

Non probability sampling was applied. This applied both purposive and snowball sampling to select the respondents for the study.

3.4.3 Purposive Sampling

This is deliberately choosing potential settings, persons or events to provide the needed information that can be obtained from other sources (Wilson, 2010). This study thus considered smallholder farmers of Kigorobya and Buseruka sub counties and the 16 key informants.

3.4.4 Snowball Sampling

The researcher used snowball sampling where respondents helped locate and identify other respondents during this study. According to Bhattacherjee (2012) snowball involves identifying a few respondents that match the criteria for inclusion in the study and ask them to recommend others they know meet the same criteria. Respondents would help directing the researcher to other respondents of the same to be involved in the study.

3.5 Data collection methods

3.5.1 Questionnaire Survey

This was used to collect primary data from smallholder farmers, and it involved use of a semi-structured questionnaires. The method of survey using semi-structured questionnaire was deemed appropriate since part of the questionnaire offers farmers choice of picking their answers form a given set of alternatives while the other part of the questionnaire allows them to qualify their responses (Amin, 2005).

3.5.2 Key Informants Interviews

Key informant interviews were used to obtain information that would assist in clarifying or improving understanding of particular issues or problems that would be raised in the household interviews. The term “key informant” in this study refers to the person who disposes specific competence/knowledge in the area of study for this case climate change issues due to academic qualification or/and many years of related work experience.

3.5.3 Content Analysis Method

A content analysis method involving a document review of related literature was also used to collect secondary data. This desk review enhanced cross-validation of data from primary sources like questionnaires and interviews.

3.6 Data collection instruments

3.6.1 Questionnaires

Questionnaires were used to collect data from farmers in Kigorobya and Buseruka Sub Counties. The questionnaire was used in this case because it has proved to be an invaluable method of collecting a wide range of information from a large number of individuals especially when it comes to people like farmers (Sekalan, 2003). The questionnaires are popular because the respondents filled them in their own convenience and are appropriate for large samples. The questionnaire was designed with both open and closed ended questions (Amin 2005).

3.6.2 Interview guide

The researcher prepared and used a semi-structured interview guide to conduct interviews with the Key Informants at the District, Sub Counties, local council levels and extension workers in Kigorobya and Buseruka Sub Counties. Interviews were chosen because they are thought to provide in-depth information about a particular research issue or question. Still, interview were chosen because they made easy to fully understand some ones impression or experiences.

3.7 Quality control methods

In order to ensure quality study findings, the researcher sought to consult with experts on the subject of study that is, 'Climate Change Vulnerability and adaptation' as a method of quality control. This was intended by the researcher to validate their opinion with the study findings especially primary data. Another method that was also applied as a quality control methods was a review of documents like reports on climate change issues as well as comparing study findings like on rainfall with available meteorological data.

3.8Data Management and Processing

After generating big volumes of qualitative information, data was coded to enable its entry using Statistical Package for Social Scientists (SPSS), cleaned and exported to STATA and EXCEL for analysis. Analyses was performed for both aggregate and disaggregated (male farmer and female farmer) samples. The logit regression model was run in STATA for both aggregate and gender disaggregated samples of the data to determine climate change vulnerability and adaptation among smallholder farmers. Gross margins arising from the use adaptation practices was determined among different farmers. The disaggregated sample was also used to run the MD-TOA in EXCEL to assess the potential impacts of climate change adaptation practices among farmers using mean net returns of the production system.

3.9Data Analysis

The study used mixed methods for data analysis. Both qualitative and quantitative methods were used. Mixed methods help in clarifying and explaining relationships found between variables which allows in-depth examination of variables (Fraenkel & Wallen, 2000). Qualitative data collected from the field was coded into themes in relation to the study objectives and research questions this created topics for discussions and analysis using the thematic analysis method.

Qualitative data was entered and analysed using the Statistical Package for Social Scientist (SPSS version 20). Analysis was done using Pearson chi-square.

3.10Ethical Consideration

The researcher attempted to observe key ethical considerations by ensuring that there exists mutual collaboration between him and all the targeted participants. The benefits from this study which involve building resilience and reducing vulnerability in the district were well explained to the respondents. This justification enhanced respondents' interests in this research. For purposes of preventing suspicion as well as making the targeted participants appreciate the study, the researcher would present clear identity and motive of the study. An introductory letter from Uganda Martyrs University was always the first identification that the researcher would present to the district officials and household respondents which enabled the study to get formal recognition.

3.11 Limitations of the study

Financial limitations whereby the study was fully sponsored by the researcher himself. It was not possible to identify a sponsor for this study, partly because of the time constraint since the researcher is in formal employment thus not able to utilise working hours to reach out to the would-be sponsors.

Weather changes was also a contributing factor towards data collection.

The researcher was assisted by one research assistant instead of two as per the study coverage due to lack of facilitation in terms of transport, airtime and up keep. Also, the study area has many tribes, some from Kigezi region, West Nile region, from Busoga region and the natives from Bunyoro region. This forced the researcher to hire a translator at a cost due to many local languages used in the area.

CHAPTER FOUR: PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.0 Introduction

This chapter presents and discusses the data that was collected during the study. The chapter lay out is aimed at addressing the study objectives and questions.

This study found out that Hoima district is experiencing depressed rainfall and multi-year droughts as a result of climate variability and change. This has a major impact on small-scale farmers whose livelihoods depend on natural resources: primarily water, land, and its bio-diversity. Although most households have developed various adaptation measures to climate change, the choice of such measures varies across space and is largely determined by socio-economic and institutional factors.

4.1 Categories of respondents in the study

The study obtained primary data from mostly two categories of people in Hoima district. These included household respondents from selected Sub-Counties as described in the methodology and key informants at both the district, sub-county and village level.

The table below shows the summary of the respondents that were involved in the study for data collection.

Table 1: Summary of the Respondents ∑136

Category of Respondents	**Number**
Household Respondents	120
Key Informants	16
Total	**136**

As shown in Table 1 above, the study involved the ordinary people at the household level as well as key informants at the district, sub-county and village level (please find a list of key informants on appendix 3). The household survey was used to elicit information on intra-household climate change experience and decision-making on adaptation strategies between men and women. Key informants were consulted for expert opinion on the subject of investigation in a general perspective. It should also be noted that the study held village focus group discussions for men, women and youth in the four villages comprised of not more than 8people per group as described in the methodology and specifically study area.

The table below shows demographic characteristics of respondents by gender, education and marital status of the respondents as shown in the below table 2.

Table 2: Demographic characteristics of respondents (Households)

Variable	**Frequency**	**Percentage**
Gender		
Male	48	40%
Female	72	60%
Total	**120**	**100**
Education		
None	20	16.7%
Primary	36	30%
Secondary	58	48.3%
Graduate	6	5%
Total	**120**	**100%**
Marital Status		
Single	53	44.1%
Married	63	52.5%
Widow	2	1.7%
Separated	2	1.7%
Total	**120**	**100%**

Table 2 shows the demographic characteristics of the household respondents. It specifically shows distribution in gender, level of education, and marital status. The table does not show distribution of main activity among the respondents because the study purposively selected areas where agriculture is the main activity given the nature of the study.

4.2 Perceptions of Respondents on Climate Change

4.2.1 Main indicators of weather changes

Various changes have been witnessed in weather conditions over the past 20 years (2006 – 2017). The most significant of these has been prolonged drought (50%) and increased frequency of dry spells (26%).

The table below shows the observable indicators of climate change experienced by the respondents in Kigorobya and Buseruka Sub Counties based on their own experience and knowledge.

Table 3: Distribution of main indicators of weather changes

Main weather changes	Frequency	Percentage
Prolonged drought	60	50%
Unpredictability of weather	16	13.3%
Prolonged rainy seasons	12	10%
Increases frequency of dry spell	32	26.7%
Total	**120**	**100%**

According to the results as shown in the table 3 above, respondents identified prolonged drought, unpredictability of weather seasons, prolonged rainy seasons, and increased frequency of dry spells as some of the observed climate change events experienced in the study area. The study further required the respondents basing on their own experience to

name which climate change event they think has been more severe. Basing in the above table, 50% of the respondents felt that prolonged drought has been most severe, 26.7% of the respondents cited increased frequency of dry spells as more severe, those who felt that unpredictability of weather seasons were more severe were 13.3% of the respondents while those who reported prolonged rainy season as the most severe were 10% and these were the least. This therefore shows that the majority of the respondents in Buseruka and Kigorobya sub-counties feel that the most severe climate change event that poses significant impact on their livelihood is prolonged drought.

All the households and key informants both men and women interviewed had observed a change in climate. As such, both men and women reported similar or identical observations of temperature and precipitation trends overtime and highlighted that for instance droughts are frequent and severe while the rains are now erratic and extended. The observed effects as reported by respondents in the study are similar with a similar study done by Bomuhangi *et al.,* (2016) where their study findings from Mt. Elgon Region, Eastern Uganda revealed that drought and erratic rains are the major climate change shocks reported to be experienced in the area. Furthermore, another study carried out in Uganda by Okonya *et al.,* (2013) in six agro-ecological zones of Uganda that is; Soroti, Masindi, Wakiso, Gulu, Kabale, and Kasese also found out that Uganda's weather-related events such as prolonged dry seasons, floods, storms, mudslides, extreme rainfall, and delayed/early rains have become more frequent and/or intense.

In agreement with the climatic events reported by respondents in the study as reported in table 3, Bwango *et al.,* (2000) agree on presence of climate changes and occurrence of various events as a result of such changes. They observed that in the past when climate variability was less erratic, most of Uganda received over 1250mm. of rainfall per annum, creating a high potential for a rich and prosperous agricultural and livestock economy; most

of southern Uganda has a bimodal rainfall distribution, making it frequently possible to produce two crops per year without the need for irrigation. However, with current climatic variability, particularly with respect to the onset, duration, and intensity of rainfall, diminishes this potential. It is therefore these events which manifest in different ways that have had devastating impacts on the livelihoods of people. However, Ibid argues that, although some of the obstacles to the development of the agricultural economy like Uganda are social and macro-economic in nature, (e.g. over-dependence on one food crop; lack of well-developed export and domestic markets; poor infrastructure/roads; inadequate access to credit and agricultural inputs), the unreliability and variability of rains is the major threat. It is reported that during El Nino years, forinstance, the onset of the rains may be delayed by one or two months, and the total amount of rainfall may increase by more than 200%, farmers can lose all their crops either due to too much rain (floods and landslides) or to too little rain (drought).

It is further important to note that farmer perceptions of long-term changes in precipitation were consistent with rainfall data as revealed by district officials during key informant interviews. This was done by comparing the recorded meteorological data with climate change as perceived by farmers in the district or region. Perception results indicate that Hoima district is getting hotter and drier and that there are pronounced changes in the timing of rains and frequency of droughts. Similar studies in India (Vedwan & Rhoades, 2001) and South Africa (Gbetibouo, 2009) revealed that farmers' perceptions of climate variability correspond with the climate data. However, these observations are at odds with the IPCC climate models, which anticipate precipitation increase in parts of Eastern Africa, particularly between December and February. The declining continental rainfall in Eastern Africa is linked to the anthropogenic warming of the central Indian Ocean that disrupts onshore moisture transports (Cane, *et al.*, 1986; Funk, *et al.*, 2008).

The table below shows the main identified causes of climate change according to the participants in this study and these causes were identified as; encroachment on wetlands, deforestation, natural causes (floods, landslides among others), and the ever growing population, as shown in below;

Table 4: Causes of climate change

Causes of climate change	**Frequency**	**Percentage**
Encroachment on wetlands	10	8.4%
Deforestation	82	68.3%
Natural causes	0	0%
Growing population	28	23.3%
Total	**120**	**100**

Table 4, shows that there are four main identified causes of climate change according to the participants in this study and these causes are; encroachment on wetlands, deforestation, natural causes (floods, landslides among others), and the ever growing population. The table further shows these have different levels of causing climate change and as reported in the table, deforestation is perceived to the leading cause of climate change reported at 68.3% of the respondents followed by growing population at 23.3% of the respondents, 8.4% of the responded feel that encroaching on wetlands is the leading cause of this vive while natural causes was mentioned that climate changes have been a result of nature but no respondent mentioned it as the leading cause of climate change. It is evident that all the causes mentioned by study respondents are clearly resulting from human activities just as the IPCC concludes that global warming observed over the last 50 years is attributed to human activities which human interventions are largely causing these changes in the global and local climate systems (Dankelman, 2002).It therefore implies that all human-environment systems adapt to climate and its natural variation and as such, adaptation to human induced change in

climate has largely been envisioned as increments of these adaptations intended to avoid disruptions of systems at current locations. In some places, for some systems, however, vulnerabilities and risks may be so sizeable that they can be reduced only novel dramatically enlarged adaptations, the reorganization of vulnerable systems, or charges in their locations.

Effects of climate change events experienced by the smallholder farmers of Kigorobya and Buseruka sub counties in Hoima District;

Table 5: Showing the relationship between main source of income and knowledge about the impact of climate change in Kigorobya and Buseruka sub counties in Hoima District

Knowledge about the impact of climate	**Main source of income**					**Total**
	Crop production	Animal husbandry	Trade & business	Salaries	Tree growing	
Crop failure	66	0	0	0	0	**66**
	68.0%	0.0%	0.0%	0.0%	0.0%	**55.0%**
Animal/crop disease and pest infestation	5	5	1	1	0	**12**
	5.2%	71.4%	12.5%	25.0%	0.0%	**10.0%**
Food scarcity/famine	0	0	2	1	3	**6**
	0.0%	0.0%	25.0%	25.0%	75.0%	**5.0%**
Increased poverty	26	2	5	2	1	**36**
	26.8%	28.6%	62.5%	50.0%	25.0%	**30.0%**
Total	**97**	**7**	**8**	**4**	**4**	**120**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0 %**

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	103.409[a]	12	.000
Likelihood Ratio	72.271	12	.000
Linear-by-Linear Association	15.830	1	.000
N of Valid Cases	120		

a. 17 cells (85.0%) have expected count less than 5. The minimum expected count is .20.

Table 5, above shows a significant relationship between main source of income and knowledge about the impact of climate change by small holder farmers. The Pearson chi-

square=.000 shows a very strong relationship between the two variables. For instance, small-holders farmers mainly in crop production have a high knowledge that climate change will bring about crop failure (68.0%), increase poverty (26.8%) and lead to disease and pest infestation (5.2%). Also, smallholder farmers in animal production have a vast knowledge that climate change will bring about animal/crop disease and pest infestation (71.4%) thus leading to increased poverty levels (28.6%) amongst smallholder farmers.

These study findings are similar with what Lambrou & Piana (2006) reported that most climate change negative impacts have generally been in form of decreased availability of water, reduced crop yields, widespread increased risk of flooding and landslides, human health issues where a number of people are exposed to vector and water-borne diseases.

It is further found by Bwango *et al.,* (2000) that, although climate change impacts upon Uganda are difficult to quantify due to uncertainty about the rate of climate change, and its magnitude, the Uganda country study identified many specific impacts which might be anticipated in agriculture, livestock and rangelands, forests and forestry, and water resources. They argued that in general, the drier areas are likely to experience increased drought episodes and more rainfall variability with negative consequences for the agricultural economy. Furthermore, Goh (2012) found out that climate change increasingly affects the livelihoods of people, and poor people experience especially negative impacts given their lack of capacity to prepare for and cope with the effects of a changing climate which affect men and women differently. The negative impacts of climate change are becoming increasingly evident today, including longterm changes in average temperature and rainfall; changes in the intensity, timing, and geographic distribution of rainfall; an increase in the frequency of extreme events such as drought and flood; and sea level rise (Ibid). These impacts will have detrimental effects on agricultural productivity, biodiversity and ecosystem services.

Table 6: Most vulnerable to climate change effects between men and women

Response	Frequency	Percentage
Men	20	14.7%
Women	116	85.3%
Total	**136**	**100%**

Much as climate change affects both men and women, respondents nonetheless were tasked to mention who they think is more vulnerable to the climate change between men and women. This question was asked in households, focus group discussions as well as key informants. According to table 6, majority of the respondents across all categories of participants (households and key informants) at 85.3% are of the view that during harsh climatic changes for one reason or the other, women are most vulnerable while only 14.7% think men are more vulnerable. Respondents were then asked why they think women are more affected than men by climate change. Various responses given by the respective categories of participants in support of this perception were generalised.

4.2.2Reasons why women are more vulnerable to the impacts of climate change compared to their male counterparts

- Women do not have alternative sources of income
- Women don't have resources such as land, money to enable them adapt the changes
- Women are heavily dependent on agricultural production (which is usually affected by climate change) unlike men who tend to have other sources of income.
- Women are more affected due to their household responsibilities like child care and collection of firewood, and water among others.
- Women are more illiterate compared to men
- Women have limited access to information

- Women are in most cases left out from decision-making

Results in table 6 generally reveal that most participants find women to be more vulnerable to the impacts of climate change compared to their male counterparts. Nabikolo *et al.,* (2012) is in agreement with the study findings when they noted that and found out that men and women farmers in many developing countries experience different levels of vulnerability and adaptive capacity to climate change. They found out that in Uganda and many other African countries, access and control over land and complementary factors of production is lower in female-headed households compared to male-headed households and that women also face severe time constraints as result of their heavier burdens of the household tasks and large families with long distances to move to and from their farms and market. Mac Gregor (2010) similarly found out that climate change affect men and women differently, but also that women are more vulnerable to the impacts than men as women are more dramatically affected by environmental degradation than men due to their social roles as provisioners and carers and in their social location as the poorest and most vulnerable at the bottom of social hierarchy alongside children. That for example, there is a strong correlation between gender inequalities and women's survival rate in natural disasters such as droughts and floods. The World Health Organisation has estimated that women are up to 14 times more likely than men to die as a result of natural disasters and women's every day caring and provisioning work is made more difficult due to climate change related impacts (Ibid).

It is argued by Goh (2012) that, when considering the gender differentiated impact of climate change, a hypothetical example may be that a climate signal such as a drought occurs in a rural agricultural environment that causes crops (a biophysical characteristic) to fail. The failure of subsistence crops may prompt women to sell off assets such as small livestock or seek other means of generating income to provide for her family. Men's larger involvement in cash crop production and waged labour may mean that they lose wages when these crops

fail, or they may temporarily migrate to other areas in search of other jobs. These impacts demonstrate different user characteristics between women and men in the vulnerability context. Women and children may suffer more food insecurity than men, children may drop out of school when school fees can no longer be afforded, and more women may become heads of households when their husbands migrate in search of work, which may additionally burden them (Ibid)

It should also be noted however, that much as it is a fact that women are the most affected during such climate change events as it has been revealed by many studies, women have also exhibited abilities of shouldering through these climate change challenges as Dankelman I (2002) noted that, there is a tendency to talk about gender aspects of climate change as if women are only victims, yet many studies show, however that women have been instrumental.

4.2.3 Coping and Adaptation options to climate change and Variability in the Study Area

This section presents study findings of mechanisms and decision making among men and women on climate change adaptation. The outlay of the findings in this section is based on the fact that respondents have accepted the fact that climate change and its impacts are a reality and that measures of adaptation amidst climate change impacts are critical. This is in consonant with Mac Gregor (2010) whose study concludes that climate change arguably presents the largest challenge humankind has ever faced with predicted and observable impacts of climate change frightening and as such, the scientific consensus about these projections, expressed by the IPCC among others, has shifted the debate away from the question of whether or not anthropogenic climate change is happening toward debates about what is to be done by whom, when and how.

Table 7: Distribution of farmers/households adjusting farming practices to cope to climate change

Response to climate change	Frequency	Percentage
Adjusting	102	85%
Nothing	18	15%
Total	**120**	**100%**

According to study findings as shown in table 7most farmers (85%) in the district reported to have adjusted their farming practices to long-term climate change. Only 15% have not adjusted. This implies that the majority of farmers acknowledge the need of adjusting their farming practices in order to cope with the changing climate. This is in agreement with Orindi & Eriksen (2005 who noted that households adopt various strategies when faced or confronted with unanticipated livelihood failure. Such adaptation involves changing the social and economic framework within which livelihood and coping strategies take place, that is, adjustments to improve long-term livelihood security. Local level coping strategies to shocks such as drought and flood differ among households and communities depending on the types of resources, economic activities and social networks that they can access; activities may range from collection of wild fruits, depending on financial assistance, switching to non-farming activities, migrating to other areas, or in extreme cases sale of assets (Ibid).

The table below shows practices which were categorised into seven. Measures were identified as farmers' responses to increased temperatures and reduced precipitation.

Table 8: Distribution of coping measures mentioned amongst respondents

Adaptation practice	Frequency	Percentage
Soil conservation schemes	38	31.7%
Changing crop types and varieties	30	25%
Reducing the number of livestock	20	16.7%
Different planting dates	10	8.4%
Diversification to non-farming activity	8	6.6%
Water harvesting schemes	8	6.6%
Reducing the size of land under cultivation	6	5%
Total	**120**	**100%**

Coping practices were categorised into seven. Measures were identified as farmers' responses to increased temperatures and reduced precipitation. That is; soil conservation schemes (31.7%), changing crop varieties (25%), reducing the number of livestock (16.7%), different planting dates (8.4%), diversification to non-farming activity (6.6%), water harvesting schemes (6.6%), and reducing the size of land under cultivation (5%). Other coping measures were cited by less than five percent of farmers.

Table 9: Distribution of use of Indigenous/Local knowledge (IK/LK) as an adaptation strategy among farmers

Response of the use of IK	Frequency	Percentage
Reported to use IK	64	53.4%
Do not use IK	56	46.6%
Total	**120**	**100**

The study revealed that one of the coping strategies applied by farmers to adapt to the impacts of climate change is the use of indigenous or local knowledge. Table 9 Shows that 53.4% of the farmers use indigenous knowledge as a form of coping strategy and 46.6% said they did not use indigenous knowledge as a coping strategy. The findings of this study are in agreement with a study carried out in Eastern Uganda by Egeru (2011) where he found out that like any other indigenous population of the world who have lived in balance and/or quasi harmony with nature, Ugandans have been unequivocally good custodians of their environment and as such, over long periods of time people have acquired detailed knowledge about the functioning of their immediate environment including observations and insights on a wide array of issues. This has been vital in responding to environmental challenges including floods, droughts, diseases and pest infestations, and their attendant effects (Ibid). One respondent in one of the focus group discussions is quoted *saying that droughts in particular are not a new phenomenon to Hoima, and over time they have developed particular indigenous knowledge to cope with like Early warning systems such as Migratory birds, Massive collection of pollen and nectar, as a sign of prolonged rain season reddish yellow sky and shading off of tree leaves as a sign on dry spell.*

4.2.4 Ways of improving and promoting indigenous knowledge in climate change adaptation

After acknowledging the importance of the use of indigenous knowledge as an adaptation strategy among farmers, the study sought to find out from farmers how best they think indigenous knowledge could be improved or promoted as a method of coping and adapting to climate change effects. Below are some of the suggestions given by farmers and key informants;

- Put up an archive on indigenous knowledge in relation to climate change adaptation in the district
- Carry out a questionnaire interaction with elders who are knowledgeable on climate change
- Avail indigenous knowledge reporting method.
- Carry out a survey on indigenous knowledge
- Try as much as possible to incorporate indigenous knowledge by use of experienced people who know how the rivers, swamps were behaving and how they are now behaving
- Publicize the indigenous knowledge to famers on radio programs, Organising seminars aiming at interacting with farmers
- Call for indigenous knowledge competitions and awards ceremonies and processes
- We should be aware that indigenous knowledge is the source of the present generation hence modernity
- There should be an interaction with cultural leaders
- Giving chance to end users (farmers) to bring their proposals.

The table below shows the various factors that determine the level of adaptability to climate change effects among smallholder farmers of Kigorobya and Buseruka sub counties;

Table 10: Distribution of determinants of climate change adaptation capacity

Determinants	Frequencies	Percentages
Land ownership	**10**	**8.3**
Access to credit	**30**	**25**
Gender of household head	**2**	**1.7**
Level of awareness	**48**	**40**
Availability of agricultural inputs	**27**	**22.5**
Size of household	**3**	**2.5**
Total	**120**	**100**

The study revealed that there are various factors that determine the level of adaptability to climate change effects among farmers. Among the various factors mentioned, farmers feel that the level of awareness on issues concerning climate change and adaptation is the leading determinant. Access to financial resources is also perceived to be very important when it comes to coping and adapting to climate change effects. These two are followed by other factors as it is showed in Table 10above.Education (which also determines the level of awareness) and human capital endowments are often assumed to increase the likelihood of embracing new technologies. This is because they enhance the ability of farmers to perceive climate change as found out by Nkonya *et al.*,(2008). Similarly, education enables households to access and conceptualize information relevant to making innovative decisions (Adesina & Forson 1995; Daberkow & McBride 2003; Shiferaw, Okello & Reddy, 2009; Ochieng', Owuor & Bebe, 2012, Gbegeh & Akubuilo, 2012). However, higher educational

attainment can present a constraint to adoption because it offers alternative livelihood strategies, which may compete with agricultural production.

Table below shows decision making amongst smallholder farmers;

Table 11: Who takes mostly the decision on the adaptation strategy in the household

Response	**Frequency**	**Percentage**
Men	30	22%
Women	70	51.5%
Jointly	36	26.5%
Total	**136**	**100%**

The study sought to find out gendered decisions with regard to adaptation strategy in households. Results as in Table 11 show that 51.5% of the respondents who are the majority were of the view that women take most of the decisions regarding adaptation strategies on behalf of the household, 22% of the respondents said that men take the lead in decisions on adaptation mechanism while 26.5% of the study respondents said that decisions regarding adaptation mechanisms to climate change are jointly made between husbands and wives in households.

The findings therefore, imply that there are gender aspects in decision-making on adaptation strategies in the household. Figures in the table 11 show that women are key players when it comes to making which adaptation strategy should be adopted. These study findings on decision-making are in line with Dankelman (2002) whose study revealed that in several disaster-related studies, it is always established that there is a gender dimension to disaster mitigation and environmental management and that women cope with disasters in different ways to men. The study further goes on to reveal that, for instance, women's indigenous

knowledge and practice of environmental management play a crucial role in the natural resource management but their contribution goes unnoticed. Women's technological ability to cope with the changing circumstances is demonstrated as they carry out a number of innovations and adaptations, which are generally embedded in their daily lives(Ibid).

It is however, important to observe that the active participation in decisions concerning adaptation strategies is not in agreement with many studies as it is already seen from the discussions in this chapter and generally in literature reviewed in chapter 4 as generally most literature show that women are not involved in decision-making of natural resource management just like Ibid puts it that women play only a limited role as producers and that during climate change negotiations, almost no attention has been paid to the need to involve women, or gender aspects, fully in the deliberations. Much as it is true that women generally might not be involved in making key decisions, we should however, consider finding out at what level women are not involved in decision making as studies such as this reveal that men in most cases are not even bothered not knowing what happens in the gardens or farms leaving all the responsibility to their wives.

Table 12: Is what is being done adequate to cope with climate change

Response	**Frequency**	**Percentage**
Yes	96	70.5%
No	40	29.5%
Total	**136**	**100%**

Much as the community have in place some adaptive practices in place, results from table reveal that when asked whether they feel that what is being done is adequate to prevent or enable recover from climate change impacts, 70.5% feel that what is done is not adequate

enough to sustainably safeguard the community from likely climate change shocks or events already experienced, the remaining 29.5% of the respondents felt that what is being done is enough.

Table 13: Constraints communities face in adaptation to climate change

Category of respondents	**Constraints faced**	**Frequencies**	**Percentages**
Household	Over reliance on rain fed agriculture	27	22.5
	Poverty	9	7.5
	Ignorance or lack of awareness	42	35
	Attitude	3	2.5
	Limited land to enable adaptive practices	9	7.5
	Lack of access to credit	30	25
	Total	**120**	**100%**
Key Informants	Lack of resources to reach out to the community	2	12.5%
	Negative mind-set	4	25%
	Enforcement of policies is a challenge	2	12.5%
	Cost of adaptation is still a barrier	2	12.5%
	Under funding of relevant departments	4	25%
	Lack of demonstration farms	2	12.5%
	Total	**16**	**100%**

Table 13 shows some of the constraints or barriers to climate change adaptation mentioned among communities at household level as well as key informants who raise some constraints at the district level inform of policy. Respondents were free to give multiple answers which were generalised as shown in the table for each respective category of respondent. As such, frequencies and percentages for each response (barrier or constraint) is not provided. Bwango *et al.,* (2000) found out that much as climate events such as droughts, El Nino are evident,

forecasting the occurrence of these climate shocks is still in its development stages, even where weather predictions are made, the farming communities do not yet take them seriously and it also seems that many potential users of meteorological products do not have the capacity to interpret and use them optimally. This observation made by Bwango *et al.,* (2000) may seem a challenge at national and regional level but its consequences are felt at the lowest level of household.

One other constrain reported by respondents is attitude and perception, this was also found out by Osbahr *et al.,* (2010) to be among the most obstacles to adaption. They found out that it is important to pay reasonable attention to local perceptions of climate in human adaptation to climate change, recognizing that understanding local knowledge is crucial to assess how farmers value both risk and information and why they select particular services and whether they choose to invest in subsequent ownership and self-innovation of extension projects. Perception of climate risk and perception in general is highly influenced by people's opinions and values, which are in turn influenced by economic, cultural and social environment. There's a strong link between perception and behaviour, and perception of climate risk will affect adaptation management; a first step is to identify local perceptions and evaluate how these views relate to the climate data (Ibid).

Table 14: Suggestions for better adaption to current and future impacts of climate change

Category of respondent	Suggestion	Frequencies	Percentages
Key Informants	More mainstreaming of climate change in other programmes	2	12.5%
	More training of technical people	4	25%
	More community sensitization on climate change issues	2	12.5%
	More funding from government	4	25%
	Increase on enforcement e.g on cutting trees	2	12.5%
	Recruitment of more technical staff	2	12.5%
	Total	**16**	**100%**
Households	More sensitization in form of trainings	30	25%
	Providing more extension farmers	18	15%
	Government should provide inputs to farmers	12	10%
	Provision of credit facilities to farmers by government	30	25%
	Regulation of prices of agricultural produce	8	6.7%
	Reintroduction of farmers' cooperatives	6	5%
	Creation of alternative sources of income	12	10%
	More natural resource protection	4	3.3%
	Total	**120**	**100%**

Table 14 provides suggestions which community members and key informants think should be done to adapt well to current and future impacts of climate change. These are suggested alongside what is currently used as adaptation practices. Suggestions from table 14 mean that adaptation measures are required at different levels to manage the impacts of climate change sustainably. This is in agreement with Bwango *et al.*, (2000) who argues that adaptation can and should take place at all levels in society, from national strategic development thinking to the local and individual level. A national strategy will, therefore, necessarily contain many components, most of which depend on additional financial resources. At an aggregate level, it seems true to say that rapid economic growth to increase national wealth and disposable income through society is an indispensable condition for strengthening national capacity to respond to climate (Ibid).

Table 15: Showing the relationship between main source of income and climate smart technologies adopted

Climate smart technologies	**Main source of income**					**Total**
	Crop production	Animal husbandry	Trade & business	Salaries	Tree growing	
Mulching	10	1	0	1	1	**13**
	10.3%	14.3%	0.0%	25.0%	25.0%	**10.8%**
Agroforestry	0	0	6	3	0	**9**
	0.0%	0.0%	75.0%	75.0%	0.0%	**7.5%**
Inter-cropping	24	0	2	0	3	**29**
	24.7%	0.0%	25.0%	0.0%	75.0%	**24.2%**
Use of organic manure	5	0	0	0	0	**5**
	5.2%	0.0%	0.0%	0.0%	0.0%	**4.2%**
Crop rotation	54	3	0	0	0	**57**
	55.7%	42.9%	0.0%	0.0%	0.0%	**47.5%**
Fallowing	4	3	0	0	0	**7**
	4.1%	42.9%	0.0%	0.0%	0.0%	**5.8%**
Total	**97**	**7**	**8**	**4**	**4**	**120**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	118.450[a]	20	.000
Likelihood Ratio	80.256	20	.000
Linear-by-Linear Association	16.982	1	.000
N of Valid Cases	120		

a. 25 cells (83.3%) have expected count less than 5. The minimum expected count is .17.

Table 15 above shows a significant relationship between main source of income and climate smart technologies adoption by small holder farmers. The Pearson chi-square=.000 indicates a very significant relationship between source of income and choice smart technologies. Small-holders farmers practicing crop production have a high preference for adoption of crop rotation (55.7%), inter-cropping (24.7%) and mulching (10.3%). Likewise, smallholder farmers practicing animal husbandry have a high preference for the adoption of crop rotation (42.9%), fallowing (42.9%) and mulching (14.3%) according to table 15 above. Farmers in trade and business, their adoption was in agroforestry (75%) and inter-cropping (25%).

Figure 3: FGD for women in Kigorobya

In all the FGDs in Kigorobya, the Effective Micro-Organism (EMO) or Indigenous Micro-Organism (IMO) is one of the unique conservation practices that farmers use as organic manure to conserve soil fertility. They said that these work bi-stimulants which promote plant growth (crops). These are tapped from the earth/soils. They are anaerobic as they do not require oxygen to survive, and they mix admirably with the aerobic ones to enhance soil fertility. They are equal friendly in that they rejuvenate the soils for agricultural productivity than the chemical and artificial fertilizers which destroy the soils in the long run. They can be used as fertilizers and spray to the crops and at the same time useful to livestock.

Table 16: Distribution of land preparation practices

Practice	Frequency	Percentage
Till the land using a hand hoe	72	60%
Plough using oxen	6	5%
Slash and Burn	24	20%
Slash	8	6.7%
Use herbicides	10	8.3%
Total	**120**	**100%**

Most respondents in the two sub-counties reported to be using the hand hoe to till their land these comprised 60% of the respondents. The practice of slash and burn was the second land preparation approach comprising of 20%, 8.3% of the respondents reported the use of herbicides/spraying as a land preparation practice, those who reported just slashing as land preparation practice were 6.7% while the least at 5% reported plough using oxen as a preparatory practice for the next planting.

Key informant interviews, revealed that most farmers slash their sites as the first operation. Most of them follow this with burning and then cultivation while others a few cultivate without burning. It was further revealed that large scale farmers use tractors to plough, others use Oxen, while some use herbicides. It was further revealed that most of those farmers that use tractors cut existing trees, remove stumps, logs and burn before ploughing. Most small-scale farmers were reported to use hand hoes to prepare their land after slashing and burning the area.

The FGDs of men, youth and women in Buseruka and Kigorobya sub-counties all revealed similar observations that the key informants provided. However, women indicated that they collect the slashed grass and only burn it from the boundary of the site being prepared.

Figure 4: FGD of youths in Buseruka

Figure 5: FGD of men in Kigorobya

Key informant interviews further revealed that slash and burn followed by cutting down of trees is the most common practice of land preparation. However, use of herbicides has become common in the last three years.

One key informant was quoted to have said: *using herbicides is less labour intensive and one does not spend on ploughing. It is commonly used by maize producers*. The FGDs of women, men and youth in Buseruka and Kigorobya, identified two main types of land preparation which included; slash, burn and plough using a hand hoe and slash and application of herbicides. Men and Women FGDs were the only ones that revealed burning as one of the practices in land preparation.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents a summary, conclusion and recommendations of the study on climate change vulnerability and adaptation in Buseruka and Kigorobya sub-counties in Hoima district. Despite the enormous challenges brought about by climate change, the chapter presents a message of hope that if better adaptation strategies are put in place, the environment can be recovered as all is not yet lost and as such climate change events/shocks experienced like prolonged droughts can be no more. The study goes on to suggest areas for further research which the researcher think have the potential to spur sustainable environmental management and human development in general.

5.1 Summary of findings

The study revealed that there are indeed observable climate changes in Buseruka and Kigorobya sub-counties in Hoima district which are attributed to human activities and whose effects have been felt immensely throughout people's livelihoods. The study established that the impacts of climate change has affected people differently depending on location, age, levels of income, knowledge, and gender. Social issues like for instance gender have been found to be critical in influencing climate change related decisions like adaptation strategies in many households. Dankleman (2008) argues that there are causes for concern in integrating such social issues in climate change adaptation; the inequalities in women's status such as poverty, lack of assets, lack of education, unequal access to information and their livelihood systems of multi-tasking.

The survey targeted household farmers preferably household heads because climate change adaptation involved decision making, on choice of crop and allocation of resources for production, and heads of households highly influence this process.

The study found out that, in response to the effects of climate change, farmers in Buseruka and Kigorobya sub-counties in Hoima district as a whole have in place adaptation practices which included looking for alternative sources of income, changing planting dates or late, practicing agro-forestry, tree planting, planting early maturing crops, use of drought tolerant crop varieties.

The study highlights the gender differences in climate change adaptation decisions in households between men and women. Results suggest that much as women are generally perceived not to be involved in key decisions of environmental management, women were reported to be the key decision makers when it comes to deciding on which adaptation strategies taken by the household to mitigate or overcome climate change challenges. Much as there are other gender inequality that increase women vulnerability like limited resources among women compared to their male counterparts, the study does not demonstrate the usually portrayed picture on inequality of not involving women in decision-making with respect to climate change adaptation. These findings reflect the fact that women by their gender roles are the custodians of natural resources on a daily basis and such ought to be key decision makers. Adaptation is fostered or constrained by specific factors for each gender category requiring specific interventions for men and women. These important findings if not noted will undermine the ability of agriculture as a tool to transform lives, alleviate hunger and fight poverty among farmers.

The study underscores the notion of gender differences in climate change issues as the study reveals that men and women are affected differently by impacts of climate change and more still, that women are most affected/vulnerable compared to men for various reasons which limit their adaptive capacity and these include but not limited to: lack alternative sources of income among, lack of resources by women such as land, money to enable them adapt the changes, heavy dependent on Agriculture.

This study particularly highlights the fact that climate change adaptation has a cost implication for smallholder farmers. Without sufficient resources, services or government interventions, particularly credit, farmers may not effectively utilize the resources and climate related technologies particularly inputs necessary to effectively adapt to climate change and bring them out of poverty. This issue is a constraint for both male and female farmers that have lower capacity to access inputs.

5.2 Conclusion

- Farmers in Buseruka and Kigorobya sub-counties in Hoima district are exposed to climate variability at intra-and inter-annual and decadal time scale. The increasing climate variability and reduction in precipitation have serious implications on human or community livelihoods directly and directly. Direct effects are reported to be inform of severe crop failure leading to famine, livestock deaths, and pest infestation among others. Indirect effects are manifested in form of poverty, poor health due to malnutrition, social conflict due to scarcity of resources among several others.
- Climate data and farmer perception indicate that farmers are aware that the district and mid-western region in general is getting dry with increased frequency of droughts and change in the timings of rains. Farmers with access to extension services were likely to perceive changes in climate.
- Most farmers have embraced at least one adaptation strategy, which are mainly influenced by perceptions/attitude, level of awareness, access to credit, size of cultivatable land among others. Some of the reported adaptation practices or coping mechanisms include; changing crop varieties, soil conservation schemes, crop rotation, water harvesting among others.
- Indigenous knowledge was one of the unique adaptation strategies the study found out to be informally applied by the farmers based on Early warning systems (Migratory

birds, Massive collection of pollen and nectar by bees as a sign of rains, Reddish yellow sky and Shading off of tree leaves, as a sign of dry spells) and underscored its importance but acknowledge that it is however not well harnessed.

- The findings of this study resonate with the literature on adoption of agricultural technologies. The level of knowledge or awareness, access to extension services, access to land, and access to resources, and size of land were found to determine the extent to which individual farmers respond to the perception of a changed climate.
- While farmers in Hoima district have, for a long time, developed local strategies to cope with erratic environmental shocks, increased variability and extreme weather events have exceeded the present coping range and adaptive capacity. Enhancing adaptive capacity is therefore indispensable to strengthening resilience and reducing vulnerability. The starting point entails complementing autonomous adaptation strategies with micro-level policy responses. Formulating and implementing such policies require devolution of authority and community participation to ensure that they empower the local farmers and elevate their role in policy formulation.

5.3 Recommendations

Although most farmers in Kigorobya/ Buseruka Sub counties in Hoima District demonstrated strong self-interest in adapting, numerous obstacles constrain their options. The following Interventions are needed to create conditions that will enable the local community and individual households to take up appropriate adaptation options:

- Develop and implement integrated natural resource management in Hoima district. This calls for harmonisation of key conflicting policies in key sectors such as water, land, tourism and wildlife, mining, energy, agriculture, and pastoralism to enhance cross and inter-sectoral linkages.

- Enhance opportunities for small-scale irrigation, and water harvesting. However, irrigation investment should guarantee high water use efficiency with emphasis on water pricing, besides building farm level managerial capacity. This will require revision of existing policies and institutional frameworks in water and agricultural sectors.
- Promote formation of local rural institutions and farmer groups, and create more opportunities for livelihood diversification.
- Encourage transition to climate-smart agriculture that take an agro-ecological approach, rely less on natural rainfall, invest in long-term soil health, and use fewer external inputs, but guarantee food security.
- Improve the availability and quality of meteorological monitoring data, enhance climate modelling with robust articulation of uncertainties, and promote farmer awareness to the impacts of climate change through extension services.
- Review farmer extension systems and design farm management adoption programmes based on the socio-economic characteristics, such as years of schooling and membership to social groups of smallholder farmers.
- The study also recommends that timely planting being a less costly practice and yet easier to implement compared to use of purchased crop varieties should be promoted for all farmers; female headed households need to be specifically and selectively reinforced. In order to facilitate adoption of the practice, early warning systems should be improved so that farmers can be prepared adequately.
- Specifically, complementary interventions such as drought tolerance used together with timely planting, that maximize the relevance of technologies and bring change in more than one aspect of farmers' livelihoods for example, ease of implementation,

reduced costs, higher returns etc. would be preferred considering that farmer problems are multifaceted, and climate change is an ongoing challenge.

5.4 Suggestions for further research

The study does not pretend to have addressed all climate change challenges especially the change adaptation practices among smallholder farmers. The study has therefore suggested recommendations upon which better natural resource management practices can be promoted to propel sustainable environmental management.

The study recommends further thorough investigation to better understand the negative relationship of factors such as land ownership, and access to climate information which were otherwise hypothesized to positively influence adaptation to climate change among small holder farmers. Land owners need to be sensitized to make use of the relevant adaptation options available to them in order to promote food security in the area even as they pursue income security.

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APPENDIX 1

TOOL 1 HOUSEHOLD QUESTIONNSIRE

Household (Survey

No…….

Note of confidentiality

Dear participant, I am Simpson Twinomucunguzi a student of Master of Science in Agroecology at Uganda Martyrs University. I am undertaking a study on Climate Change Adaptation in Smallholder farmers inKigorobya and Buseruka Sub-Counties, Hoima district. The main objective of this study is evaluate the influence of gender on climate change adaptation in smallholder agroecosystems. Your participation in this study will contribute to a gendered approach to climate change adaptation. All information provided will be treated with confidentiality.

SECTION A: DEMOGRAPHIC CHARACTORISTICS

Identification information

Sub-County……Parish…….

Village……

Bio-data of the respondent

Name of Respondent……(Optional)

Contact ……. (Optional)

Sex of the respondent……

Position in the household:

1. Head
2. Spouse
3. Other specify…….

4. Marital status

Highest level of education

1. None
2. Lower primary (P.1-P.4)
3. Upper primary (P.5-P.7)
4. O-Level
5. A-Level
6. Tertiary
7. University
8. Others, specify…….

Age of household head

1. 18-24 years
2. 25-30 years
3. 31-36 years
4. 37-42 years
5. 43-49 years
6. 50-56 years
7. 57+ years

What is the occupation of the household head?

1. No occupation
2. Farmer/Agriculture
3. Trader
4. Salaried worker/professional
5. Casual labourer
6. Other specify……...

What is/are the main source of income of this household?

1. Crop production
2. Animal husbandry
3. Trade and business
4. Salaries
5. Tree growing
6. Others, specify……...

How many people live in this household?

1. Male……
2. Female ……

SECTION B: CLIMATE CHANGE EFFECTS

Have you noticed changes in climate in your area in the last 20 years?

1. Yes
2. No
3. I don't know

If yes, what significant changes in weather have you observed in this area over the last 20 years?

1. High temperature
2. Low temperature
3. Changes in rainy seasons
4. Less rain
5. Heavy rains

What do you think has led to changes in climate in this area?

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……

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What climate change events have been experienced in this area?

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Which of these climate change events has been more severe?

……

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……

How have these climate change events affected people’s livelihood?

……

……

……

Do you think men and women are equally affected by the impacts?

1. No
2. Yes

If no, who are the most severely affected by impacts of climate change and why?

……

……

……

SECTION C: ADAPTATION MECHANISM AND DECISION MAKING

Have you made any adjustment in your farming practices to climate variability and change?

1. Yes
2. No

What are the adaptation strategies used to mitigate or reduce the impacts of climate change?

……

……

……

Do you use Indigenous Knowledge as a climate change adaptation strategy?

How best do you think we can improve or promote Indigenous Knowledge as a strategy to climate change adaptation?

……

……

Who decides on the choice of adaptation strategy for the household?

1. Husband
2. Wife
3. Jointly with other family members

How do you gauge the adaptive capacity between men and women?

……

……

……

……

At household level between men and women who is more concerned with adapting to climate change and its impacts? And why?

……

……

……

……

Do you feel what is being done by the community to cope with climate change is adequate to prevent and enable their recovery from the effects of climate change?

……

……

……

……

What are the constraints that communities face in adapting to climate change?

……

……

……

……

What do you think people can do to adapt well to current and future impacts of climate change?

……

……

……

……

……

Thank You for Your Participation!

APPENDIX 2

TOOL 2 INTERVIEW GUIDE FOR KEY INFORMANTS

Dear Respondent,

The purpose of these questions is to collect data to have a better understanding of climate change adaptation in smallholder farmers and it is purely for academic purposes only.

Climate change effects

1. Have you noticed changes in climate in your district in your area/district changing over the last 20 years?
2. What significant changes have you observed in this area/district over time?
3. What are the causes of climate change in this area/district?
4. What climate change events have been experienced in this area/district?
5. Which of these climate change events has been more severe?
6. What do you think have led to changes in climate in this area/district?
7. How has climate change affected people's livelihood?
8. Do you think men and women are equally affected by climate change?
9. Who do you think is most affected by the impacts of climate change between men and women? Please explain

Adaptation mechanism and decision making

1. Do you think people have made adjustments in their farming practices to climate variability and change?
2. What are the adaptation strategies do people in this area/district use to mitigate or reduce the impacts of climate change in this area/district?
3. Who do you think decides on the choice of adaptation strategy in most households in this area/district?

4. At household level between men and women who is more concerned with adapting to climate change and its impacts? And why?
5. Do you think that what is being done by the community to cope with climate change is adequate to prevent and enable their recovery from the effects of climate change?
6. What are the constraints that communities face in adapting to climate change?
7. What do you think people can do to adapt well to current and future impacts of climate change?

Thank you for sparing your valuable time to respond to these questions

APPENDIX 3

LIST OF KEY INFORMANTS CONSULTED AT DIFFERENT LEVELS OF THE DISTRICT

1. District Natural Resource Officer
2. District Environment Officer
3. District Forest Officer
4. District Agriculture Officer
5. District Community Officer
6. Secretary to production-district
7. Sub-County agriculture extension officer-Kigorobya
8. Sub-County agriculture extension officer-Buseruka
9. Secretary to production-Kigorobya Sub-County
10. Secretary to production-Buseruka Sub-County
11. Sub-County chief-Kigorobya
12. Sub-County chief-Buseruka
13. LC1 Waaki
14. LC1 Kapaapi One
15. LC1 Kyapaloni
16. LC1 Rwamutonga
17. NARO official (Bulindi Offices)