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GENDER DIMENSIONS OF SMALLHOLDER FARMERS' PERCEPTIONS, KNOWLEDGE AND ADAPTATIONS TO CLIMATE CHANGE IN SOROTI DISTRICT, EASTERN UGANDA

BY

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DECLARATION

I, Titus Kisauzi declare that this dissertation is original and has not been submitted for any other degree award to any other University.

Signature …….. Date…….

Approval by supervisors:

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ABSTRACT

Perceptions and knowledge play a key role in shaping individual and collective response to climate change. Furthermore, understanding what types and forms of adaptation are possible, feasible and likely; and who would be involved in their implementation is an important step towards facilitating effective climate change adaptation. Also, a successful campaign should take into consideration equity which calls for extensively examining the gender aspects of adaptation to climate change. This study therefore focused on three objectives: 1) evaluating male and female farmers' climate change perceptions and knowledge; 2) identifying the determinants of knowledge of climate change among male and female farmers; 3) characterizing and evaluating male and female farmers' climate change adaptation practices; and 4) Assessing male and female farmers' contribution to household climate change adaptation. The study was carried out in three parishes of Gweri Sub-County, Soroti district, Eastern Uganda and it employed a descriptive survey design. Exploratory data were obtained from a stakeholders' workshop which was followed with a survey. Temperature and rainfall data of Soroti district for the last 30 years was also obtained from the Meteorology Department, Ministry of Water, Lands and Environment (MWLE). The survey sample comprised of 135 respondents (from 90 male and 45 female headed households), based on stratified random sampling. Data were analysed using descriptive statistics, t-tests, two-proportion z-tests, Chi-square tests, and linear and multinomial logistic regression. Results showed high levels of perception of climate changes among male and female farmers and that the perceptions of men and women were generally similar. However, with regard to knowledge, femalehousehold heads were about 11 times more likely to be ignorant about the cause of climate change and about three (3) times more likely to be wrong about the cause of climate change than their male counterparts. On the other hand, resilience of male and female farmers was not guaranteed given that the bulk of their adaptation practices were climate dependant. Adaptation ideas attributed to women (only 5%) were found to be way below the proportion attributed to men (80%) despite the fact that in 60% of male headed households women had introduced agricultural ideas in general, with 97% implementation rate. In addition, women shouldered the more labor intensive adaptation related activities, while decision making and selling of proceeds from adaptation efforts were mainly done by men. The study recommends that: (i) the communication strategy for climate change adaptation should capitalize

on the high levels of perception of climate change by availing communities with appropriate climate change information for action; (ii) while strengthening farm production practices, the national adaptation plan should put equal emphasis on developing the farm financial management profile of farmers as a cushion against climate dependency; and(iii) adaptation interventions by the various actors at national and lower levels should be deliberate in mainstreaming gender at the grassroots so that both men and women's contribution to climate change adaptation are maximized.

CHAPTER 1: INTRODUCTION

1.1 Background

Recent findings attribute climate change to increases in the concentration of the greenhouse gases (GHGs) due to human activities such as fossil fuel combustion, deforestation, and industrial processing, giving rise to global warming (IPCC, 2007). Agriculture inevitably contributes to climate change through land-use change such as deforestation for farm land and use of commercial and organic fertilizers which affect the GHG concentration (IPCC, 2007; Pidwirny, 2006). In turn, global warming is causing changes in climate properties which pose a serious challenge to achievement of the Millennium Development Goals (MDGs) (Hepworth & Goulden, 2008). Several climate change effects have been registered, including increases in global average air and ocean temperatures, widespread melting of snow and ice, rising global average sea level, and increased frequency and severity of extreme weather such as heavy rains (causing flooding), droughts and hurricanes. Consequent loss of human lives and property, and reduced agricultural productivity have been witnessed (Kareiva, 2005; Stern, 2006). Even worse, studies have predicted further changes which may result in more stressful negative impacts on the livelihoods of especially the poor (IPCC, 2007; Stern, 2006). Uganda is no exception. A recent climate risk report by Hepworth and Goulden (2008) established that Uganda is one of the most unprepared and most vulnerable countries in the world. Already climate change effects have been felt in Uganda, including increased frequency and intensity of droughts, heavy rains, floods, and erratic rainfall. The impacts of such events have included reduced crop yields, landslides, destruction of property and human life, food insecurity, and reduced incomes (NAPA, 2007; Oxfam, 2008).

Some positive impacts of climate change have been projected. For instance, Climate change is projected to bring some benefits in temperate areas, such as fewer deaths from cold exposure, and some mixed effects on the potency of malaria in Africa, but overall it is expected that benefits will be outweighed by the negative health effects of rising temperatures, especially in developing countries. Also, while crop productivity is projected to increase slightly at mid to high latitudes for local mean temperature increases of up to 1 to 3°C depending on the crop, this will not be the case for lower latitudes, especially in seasonally dry and tropical regions where crop productivity is projected to decrease for even small local temperature increases (1 to 2°C).

Further changes in local average temperature over 3°C are projected to decrease the global food production potential (IPCC, 2007). Temperatures in East Africa, for instance, are expected to rise by 3°C to 4°C in the period 2080-2099, an increase above the projected global mean (Seitz & Nyangena, 2009). In Uganda, it is predicted that a two-degree Celsius temperature rise could lead to 85% shrinkage in the area suitable for Robusta coffee growing (UNWDP, 2005; Oxfam, 2008). This poses a major threat to the coffee industry which is a major foreign exchange earner and employer in the country (MAAIF, 2011).

Societies can respond to climate change and reduce its impact through adaptation and mitigation. Adaptation refers to adjustments made to reduce negative impacts or taking advantage of new opportunities presented by changing climate conditions while mitigation refers to measures for reducing GHG concentration (IPCC, 2007). Unlike mitigation, adaptation in most cases provides local benefits, in short time scales, and is likely to be the more viable approach for small scale private actors such as individuals, households and businesses in response to actual or expected climate change, without the active intervention of governments (Stern, 2006). Stern (2006) further posits that adaptation is the only response available for the impacts that will occur over the next several decades before mitigation measures can have an effect, and the earlier effective action is taken, the less costly it will be. Notably, much adaptation will simply be an extension of good development practice – for example, promoting overall development, better disaster management and emergency response, and governments have a role in providing a policy framework to guide effective adaptation by individuals and firms in the medium and longer term. Local communities in Africa have always adapted to climate variations, based on accumulated knowledge and experience and resources available. Common adaptation strategies of both indigenous and exotic origin used by farmers in Africa include; switching crops, using improved varieties, intercropping/crop diversification and income diversification; planting trees, changing planting dates, early warning systems for extreme events, biodiversity conservation and irrigation and water management (Gbetibouo, 2009; UNFCCC, 2007). However, in view of climate change impact projections for the future, more effective adaptation is a necessity (Oxfam, 2008).

As such, the need for concretizing climate change adaptation response cannot be overemphasized. However, ensuring more effective adaptation calls for several considerations

including farmers' understanding of climate change. Both perception and knowledge guide decision making and consequently, farmers' actions in response to climate change. Perception refers to beliefs or opinions held by people based on how things seem to them (Cambridge Advanced Learner's Online Dictionary and Thesaurus, 2011). Knowledge, on the other hand, concerns the way people understand the world, and how they interpret and apply meaning to their experiences (Blaikie et al., 1997). It is also argued that in addition to limitations presented by availability of technologies, peoples' perceptions and knowledge within society can fundamentally limit climate change adaptation (Adger et al., 2008). For instance, public perceptions are critical components of the socio-political context within which policymakers operate, and can fundamentally compel or constrain political, economic, and social action to address a particular risk such as climate change (Leiserowitz, 2005). Blaikie et al. (1997) contend that knowledge within a local population is not homogeneous but may vary from individual to individual depending on gender, among others.

In addition, understanding past and present adaptation options or practices of coping with climate shocks is useful in determining how to best approach vulnerability reduction or where adaptation support should be prioritized (Hepworth & Goulden, 2008). As Smit and Skinner (2002) note, a necessary first step in climate change adaptation in agriculture is to identify and characterize adaptation options so as to understand what types and forms of adaptation are possible, feasible and likely; who would be involved in their implementation; and what is required to facilitate or encourage their development or adoption.

Undoubtedly, gender presents a compounding factor in dealing with the challenge of climate change. The socio-cultural differences between men and women in social roles, access to services, and access to and control of resources, and decision-making power particularly disadvantage women (UNDP, 2009). For instance, only 5% of women own registered land (NDP, 2010), yet women provide the bulk (86%) of Uganda's agricultural labor force compared to 67% of men (UBOS, 2003). It is also the women who depend more on the natural environment for their livelihoods, and traditionally, women perform the bulk of domestic roles, such as fetching water, firewood, and child care, in addition to subsistence work. Thus, by increasing stress in performing these tasks, climate change is likely to lead to increased workloads for women as such hinder their engagement in other activities such decision making

and income generating activities (UNFCCC, 2007). Gendered differences also point to differences in capacities, priorities and needs for men and women given their gendered experiences (UNDP, 2009). Due to such circumstances, women are more likely to be vulnerable in face of climate change, with less capacity to cope compared to men who are usually more favored in terms of control of resources and decision making.

Generally, gender and climate change literature seems to suggest that because of gendered differences, men and women are expected to differ in perceptions and knowledge as well as in the way they may adapt to climate change (for instance, UNDP, 2009). Some studies have identified that women have higher perception of stressful events such as earthquakes (Kung & Chen, 2012) and that they are bound to perceive most stressful life events such as sexual abuse, murder, and war as more distressing than men (Caballo & Cardefia, 1997). Likely explanations include that women are much more likely to be the actual or potential victims of some of these events and that in some instances, previous exposure to trauma may differentially sensitize women, so that in later exposures they are more affected than men. On the other hand, Hemmati (2005) relates women's higher perception of threat to gendered differences in power and control arguing that the less people can impact decisions and strategies regarding a particular issue, the more risky they will perceive the issue. Hemmati (2005) further posits that the differences in perception may consequently result in differences in plausible responses preferred by men and women, while higher perceptions of women could make them more natural allies in combating climate change.

However, O'Connor, et al. (1999) noted that the notion that people who perceive a relatively high likelihood of an adverse event are more likely to take personal ameliorative steps and support government initiatives to do likewise, even in the face of required sacrifice, had been rarely tested, especially for the case of long-term, uncertain environmental risks such as global warming. In their study on the willingness to address climate change O'Connor, et al. (1999) showed that men and older respondents were somewhat more likely to vote for government policies to address climate change than were women and the young while in contrast, women showed disproportionate support for voluntary actions. Knowledge about the causes of the global warming was also found to be a powerful predictor of behavioral intentions and willingness to act was predicted by knowing the causes of climate change.

On the other hand, recent gendered studies such as the three largely qualitative studies done by Babugura (2010), Omari (2010) and Ribeiro and Chaúque (2010) in South Africa, Botswana, and Mozambique, respectively, have lacked specific gendered adaptation differences between men and women in agriculture. However, some examples outside agriculture have been cited, for instance, Omari (2010) observed that climate induced poverty and lifestyle changes could force women into risky coping measures such as prostitution to sustain families, while Ribeiro and Chaúque (2010) found that successive droughts had led to an increase in men's migration to South Africa and other places in search for jobs, while women stayed home and carried on both the domestic and productive work.

Lastly, women are seen to play several important roles in the agricultural sector and possess tremendous potential to contribute to livelihoods. For instance, according to Udry (1995) and FAO (2011), increasing women's access to productive resources can significantly increase yields, and woman empowerment is a well-proven strategy for improving children's wellbeing in terms of nutrition, health and education (FAO, 2011). In Uganda, women's contribution to agricultural labor is greater than men's (UBOS, 2003) and may even increase due to male out-migration to urban centers (IAASTD, 2009). Women are also more effective than their male counterparts in translating investment into household welfare when empowered (FAO, 2011). For instance, a case study in South Africa showed that women were better at exploiting opportunities related to coping with climate stress given that men were more prone to misusing social grants on alcohol and more sexual partners rather than home priorities (Babugura, 2010). In addition, women have variant perspectives and experiences as well as valuable and unique contributions in natural resource management (IAASTD, 2009; UNDP, 2009). These unique contributions and strengths render women equally important allies as men in climate change adaptation in agriculture which is the main stay of rural areas. Given the high engagement levels of women in agriculture, their contribution towards adaptation is expected to be reasonably high compared to men. However, the gendered patterns that hinder women's potential in agriculture may likely overshadow their contribution towards adaptation to climate change in the household, especially given their limited access to decision making.

1.2 Problem Statement

Peoples' perceptions and knowledge can potentially limit climate change adaptation (Adger et al., 2008). The National Development Plan (NDP) of Uganda, for instance, identifies limited awareness of the causes of climate change or climate variability at all levels as one of the key constraints to performance of the climate change sector (NDP, 2010). Linking perceptions and knowledge of climate change to expressed behavioral intentions, O'Connor, et al. (1999) established that women's and men's behavioral responses to climate change varied with respect to their perceptions and knowledge of climate change. Although the gender variable has been found successful in predicting perceptions and knowledge in the USA for instance, gender studies in developing countries are still limited in quantitative aspects of male and female farmers' perceptions and knowledge of climate change. This has remained so despite the considerable volume of literature on gender and climate change that suggests that gender is expected to have an influence on male and female farmers' perceptions and knowledge of climate change.

Furthermore, though the Uganda NAPA labored to characterize adaptations in the country, this was achieved only to a small extent. The NAPA also observed that documentation, development and popularization of adaptation measures in Uganda were still lacking (NAPA, 2007).Further work is therefore needed to characterize adaptation options in agriculture so as to understand what types and forms of adaptation are possible, feasible and likely; who would be involved in their implementation; and what is required to facilitate or encourage their development or adoption.

Further still, successful climate change adaptation calls for consideration of generic principles of policy for wider sustainability including equity, among others (Adger et al., 2005). The Uganda NAPA itself has committed to addressing the issue of gender equity. However, as Brody et al. (2008) note, climate change is a fairly recent development and empirical references with a gender perspective on climate change are still limited. For instance, there is still limited attention given to the differences between men and women as well as insufficient data and in-depth research on women's practices and specific needs (FAO, 2007; IAASTD, 2009). Thus, research and policy-making have yet to examine extensively the gender aspects of adaptation to climate

change in addition to vulnerability (FAO, 2007). The recent empirical gendered studies such as the three largely qualitative studies titled "gender and climate change" done by Babugura (2010), Omari (2010) and Ribeiro and Chaúque (2010) in South Africa, Botswana, and Mozambique, respectively, have lacked specific gendered adaptation differences between men and women in agriculture.

1.3 Research Objectives

1.3.1 Overall objective

The overall objective of the study was to determine gender dimensions of smallholder farmers' knowledge, perceptions and adaptation options used to cope with climate changes.

1.3.2 Specific objectives

1. Evaluate male and female farmers' climate change perceptions and knowledge
2. Identify the determinants of knowledge of climate change among male and female farmers
3. Characterize and evaluate male and female farmers' climate change adaptation practices
4. Assess male and female farmers' contribution to household climate change adaptation

1.4 Significance of the Study

A global framework for responding to the challenge of climate change has been provided through the United Nations Framework Convention on Climate Change (UNFCCC). As required by the convention, Uganda has prepared its National Adaptation Programs of Action (NAPA) in view of the MDGs and national development objectives. Of particular concern were commitments to address gender equity, among others. Climate change is likely to exacerbate gender inequalities, threatening achievement of Goal Three of the Millennium Development Goals (MDG's) which seeks to promote gender equality and empowerment of women (UNFCCC, 2007). Hepworth (2010), noted with concern, absence of detailed plans, policies, and most of all, specific actions to translate this into genuine gender equity throughout the different ways Uganda undertakes to respond to the challenge. This reveals the lack of well researched linkages between gender and climate change to inform gender responsive planning and

implementation of programs. In addition, further research and training to enable adaptation is needed in developing countries in order to help to better identify effective adaptation options and facilitate better policy decisions and management (UNFCCC, 2007). Findings from this research will therefore help elaborate the range of adaptations that might be considered in initiatives to improve risk management (Smit & Skinner, 2002) as well as provide insights to enable formulation of more effective and equitable climate change adaptation at local, national and international levels.

1.5 Justification of the Study

Climate change threatens to exacerbate gender inequalities. Uganda is regarded as one of the most vulnerable and least climate resilient countries due to poverty and low income diversification (NDP, 2010). Empirical evidence is needed to enable policy-makers to influence people's actions more effectively in an effort to promote gender equity while pursuing effective adaptation.

CHAPTER 2: LITERATURE REVIEW

This chapter will explore the literature that is relevant to understanding the concepts of climate change, farmers' perceptions of climate change, and adaptation. The first part highlights the important links between gender and climate change, while the second explores the role of perceptions and knowledge in shaping how people respond to climate change response and approach to research. In the third part, a synopsis of climate change adaptation, highlighting typical adaptations, and the approaches for characterizing such adaptations is discussed. The last section presents a summary of the literature review and the gaps to be addressed by the study.

2.1 Gender and Climate Change

Gender refers to the social differences and relations between men and women which are learned, vary widely among societies and cultures, and change over time (UNESCO, 2000). Being a fairly new phenomenon, a considerable part of recent climate change research efforts has dwelt on unearthing links between gender and climate change in the interest of achieving equitable and sustainable development. For instance, Adger et al. (2005) note that successful climate change response calls for consideration of generic principles of policy appraisal harmonious with wider sustainability, including equitability in addition to effectiveness, efficiency and legitimate action. The international community now widely recognizes gender and women's empowerment as both ends in themselves and means for promoting development in general (UNDP, 2009). This section therefore explores the rationale for considering gender in the climate change debate and research.

With the socio-economic landscape of a country or society having a bearing on the spread of the effects of climate change, some members of society may be more affected than others and therefore left worse off in face of climate change (IPCC, 2001; Stern, 2006). For instance, those with low adaptive capacity (ability to counter effects of climate change) are more likely to be affected. Low adaptive capacity, which will further be reduced by effects of climate change, is associated with several factors including over-dependence on agriculture, geographic exposure, low incomes, poor public services and governance, high disease incidence, and high population growth, yet the impacts of climate change are set to further erode the little adaptive capacity (IPCC, 2001; Stern, 2006).

Even though the term gender is not synonymous to women, for a long time women have been considered the less advantaged compared to men, given the commonly patriarchal nature of societies the world over. As such, a large proportion of rural women continue to face limited access to important services such as education and information, markets, technology and credit and farmers' organizations; limited access to and control over natural resources, which result in low incomes (Barrett et al., 2009; IAASTD, 2009; World Bank, 2009). Also, family members, for instance, husband, wife, boys and girls have roles and responsibilities as may be expected of them given the prevailing socio-political and cultural constructs (UNESCO, 1995). Lastly, given the largely patriarchal state of societies, decision making and generally power is dominated by men with subsequent subordination of women (Moser, 1993).

As such, climate change is likely to exacerbate the conditions of women given their already relatively disadvantaged state in society. By this, climate change is expected to have negative impacts on Goal Three of the Millennium Development Goals which entails promotion of gender equality and empowerment of women. This is because climate change is likely to deepen gender inequality as women depend more on the natural environment for their livelihoods. Women and girls are typically the ones to care for the home and fetch water, fodder, firewood, and often food, and female-headed households with few assets are particularly affected by climate related disasters. Thus, stress as a result of climate change is likely to further reduce women's time to engage in decision making and earning additional income due to greater workloads, with greater difficulty to cope due to fewer resources (UNFCCC, 2007).

Several case studies in different African countries have shown that the capacities of men and women to adapt to climate change and the adaptive measures themselves may vary between men and women given the socio-cultural landscape. In South Africa, for instance, in face of climate change, women tended to carry extra workloads in effort to ensure the wellbeing of their households, often working longer hours than men, which affected them both physically and emotionally (Babugura, 2010). Notably, it is normally women and girls who perform tasks such as planting, transplanting, hand weeding, harvesting, picking fruit and vegetables, small livestock rearing, and postharvest operations such as threshing, seed selection, and storage, while mechanized work and marketing are generally done by men (IAASTD, 2009). On the other hand, in Botswana, it was also observed that climate induced poverty and lifestyle changes could force

women into risky coping measures such as prostitution to sustain families (Omari, 2010). In contrast, in Mozambique, Ribeiro and Chaúque (2010) found that successive droughts had led to an increase in men's migration to South Africa and other places in search for jobs. This had consequently increased women's role in productive work through brewing and fisheries-related work. Babugura (2010) noted that women's involvement in activities that generate earnings was reshaping relationships between men and women. The income generated by women through trade was being used to sustain the household and the women generating an income also had more opportunities and power to decide what the income could be used for. Nonetheless, the increased workload imposes pressure on women who have to spend extra time for productive work in detriment of domestic roles and time spent with their children (Ribeiro & Chaúque, 2010). In addition, to effectively perform such new roles, there is need for women to access additional skills as well as precautionary measures to address risks to girls and women (IAASTD, 2009).

Women's significance as well as men's in improving agriculture and community welfare sustainably cannot be doubted. In Uganda, for instance, women's contribution to agricultural labor is greater than men's (UBOS, 2003) and is likely to even increase due to male out-migration to urban centers (IAASTD, 2009). Furthermore, women have variant perspectives and experiences as well as valuable and unique contributions in natural resource management (IAASTD, 2009; UNDP, 2009) and equal treatment of men and women in accessing productive resources has proven to increase yield (Udry, 1995). Women also seem more effective than their male counterparts in translating investment into household welfare when empowered (FAO, 2011). These unique contributions and strengths render women as important allies, worthy of equal consideration in combating climate change by deliberately taking into account men's and women's unique challenges, priorities, needs and interests.

2.2 The Role of Perceptions and Knowledge in Shaping Response to Climate Change

In particular, perceptions and knowledge may facilitate or impede appropriate response to climate change. This is because adaptation may be viewed as a result of continuous stream of activities, actions, decisions and attitudes that reflects existing social norms and processes (Adger et al., 2005). Previously, limits to adaptation were viewed as exogenous (imposed from

outside society), absolute and objective realities mainly related to ecological, physical, economic or technical aspects(Adger et al., 2008). Research with such a perspective at best only provided de-contextualized information which ignored the fundamental human aspects, such as preferences, culture, emotions and institutional and intellectual frameworks (Dessai et al., 2004). The rising demand by policy makers to influence people's adaptive behavior more effectively has led to increased consideration of socio-cognitive factors in climate change response (Adger et al., 2008; Grothmann & Patt, 2003). The different aspects of knowledge and perceptions in view of climate change response are discussed below.

2.2.1 Perceptions

These changeable mind frames emanate from cultural and societal norms and values, preferences, perceived self-efficacy, knowledge, experience, and habitual behavior and partly influence individual and societal actions. For instance, they provide a framework for determining thresholds beyond which change is perceived as irreversible, different world views and priorities, ability to associate events, and appreciation of future benefits of current actions (Adger et al., 2008; Grothmann & Patt, 2003). The climate change phenomenon is viewed differently by different stakeholders, such as scientists, the rest of the public or farmers. In the book, why we disagree about climate change, Hulme (2009) presents climate change as a physical phenomenon on one hand, and on the other, a social phenomenon, the two being different from each other. The former relates to natural science where climate change can be observed, quantified and measured, while the latter relates to the role of humans as active agents in reshaping of physical climates, mediated by social, political, cultural and ethical practices, giving rise to different interpretations of climate change. Thus, depending on who one is, and where one stands, the idea of climate change carries different meanings and may imply different courses of action. For instance, some farmers, just like some members of the general public, are skeptical that climate change is real. Others are doubtful it will affect agriculture, and some don't even want to bring it up for fear it might generate yet another concern about the environmental impact of farming (Grubinger, not dated). Popular contemporary contrasting ways of narrating the significance of climate change include, climate change as a battleground between different philosophies and practices of science; climate change as a justification for commoditization of the atmosphere; climate change as the inspiration for a global network of new or reinvigorated social movements;

and climate change as a threat to ethnic, national and global security (Hulme, 2009). Understanding why the different viewpoints exist will also help to better understand how to moderate collective response to the climate change phenomenon.

Inasmuch as the objective ability or capacity of a human actor (what an individual, a group, or a culture could do, indicated by the availability and the access to resources) determines the adaptive response, it only does so in part. The subjective ability of human actors is equally as important since the subjective ability can be very different from the objective ability (Grothmann & Patt, 2003). Grothmann and Patt (2003) give an excellent illustration to this regard when they found that Bangladesh Muslim women when alone at home did not make use of the cyclone shelters after a cyclone warning was given, simply because they did not think that they could leave the house without their men as dictated by religious normative beliefs. Further still, in addition to subjective adaptive capacity, Grothmann and Patt (2003) argue that motivation is another major psychological determinant of adaptation. It relates to perceived threat and possibility of adaptation to avert the threat, thereby safeguarding what is perceived as valuable. In this case, the higher the stakes, the higher the motivation to act.

The above ideas, that is, subjective and objective ability were the basis for formulating the social learning theories/cognitive theory which holds that behavior is determined by expectancies and incentives. From Rosenstock et al. (1988), expectancies include: expectancies about environmental cues (that is, beliefs about how events are connected- about what leads to what); expectancies about the consequences of one's own actions (that is, opinions about how individual behavior is likely to influence outcomes) or outcome expectation; and expectancies about one's own competence to perform the behavior needed to influence outcomes or efficacy expectation (self-efficacy). On the other hand, incentives include: reinforcement defined as the value of a particular object or outcome. The outcome may be health status, physical appearance, approval of others, economic gain, or other consequences. Behavior is regulated by its consequences (reinforcements) as interpreted and understood by the individual. Thus, for example, individuals who value the perceived effects of changed lifestyles (incentives) will attempt to change if they believe that (a) their current lifestyles pose threats to any personally valued outcomes, such as health or appearance (environmental cues); (b) that particular

behavioral changes will reduce the threats (outcome expectations); and (c) that they are personally capable of adopting the new behaviors (efficacy expectations).

These same ideas have inspired studies on perception of climate change. Dessai, et al. (2004) caution that in order to make outcomes of such studies more useful, effort should be made to explicitly link public perception of climate change with behavioral change. It is thus critical to identify what the public perceives as important and then from there determine how climate change may affect what is important so as to focus intervention.

Some studies have reported high perception of climate changes by farmers. For instance, according to Nhemachena and Hassan (2007) in a micro-level analysis of farmers' adaptation to climate change in Southern Africa found that farmers perceived that the region was getting warmer and drier with increased frequency of droughts and changes in the timing of rains. Observed trends of temperature and precipitation were in support of farmers' perceptions. Further, findings by Ishaya and Abaje (2008) on perceptions of climate change in Nigeria revealed that indigenous people perceived that the climate had been changing over the years due to diverse human activities. Findings also revealed that the threat of climate change was more on health, food supply, biodiversity and fuel wood than on businesses and instigation of disaster. Other studies include Gbetibouo (2009) in Limpopo basin, South Africa and Fosu-Mensah et al. (2010) in Sekyedumase District in Ghana.

Perception of climate change is mediated by a range of factors including education, farming experience, farm size, type of farm e.g. crop farm, soil fertility, access to water for irrigation, access to extension services, and access to climate information. Apart from revealing high perception of decreasing precipitation and increasing temperatures in both instances, Gbetibouo (2009) also found that educated farmers were less likely to perceive changes in precipitation over time, while farmers who have access to water for irrigation were less likely to perceive any change temperature or rainfall, and that farmers with experience and farmers who have access to extension were more likely to perceive change in temperature. On the other hand, farmers with fertile soil were less likely to perceive change in temperature but more likely to perceive change in rainfall. However, the gender aspect of perception was not considered in the analysis.

Vedwan (2006) in a study on culture, climate and the environment, local knowledge and perception of climate change among apple growers in Northwestern India concluded that perceptions of climate change, embedded in the traditional notions of risk, served to politically legitimize the claims of the apple growers, which might otherwise be dismissed by the dominant institutions. Here, perceptions of the apple farmers, that is, amount and timing of snowfall over the last three decades inspired development of a local solidarity movement for redressing the failure of the state, especially its scientific-technical apparatus, and the market to address the apple growers' problems. More insights may be obtained from Williamson, et al. (2005) in a study on perceptions of climate change risk to forest ecosystems and forest-based communities among experts in British Columbia. The experts acknowledged that the effects of climate change on forests and forest-based communities were not well understood by the general public or forest managers, and that there was a relatively high level of uncertainty about the effects of climate change. An important implication was reinforcement of the need for greater awareness of climate change to reduce levels of uncertainty about future impacts at local scales. In this pursuit it should be noted that although poor village communities may have a good understanding of climate variability, it may not be in the context of the long term, which may make difficult for them to weigh up the costs and benefits of investing in adaptation (Stern, 2006).

2.2.2 Knowledge

The different perspectives (scientific or otherwise), for example, about future climate can bring about differences in values which influence adaptation decisions. Fundamentally, in assessing possible adaptation responses, individuals, institutions or governments are guided by their knowledge about weather and climate from the deep past through the present to the long future (Adger et al., 2008). Similarly, UNFCCC (2007) posits that farmers generally respond to climate related challenges based on accumulated knowledge and experience, in addition to available resources. Notably also, smallholder farmers' understanding of climate change is reflected in their knowledge of the causes of climate change and the solutions to the challenges it poses. For example, in the study on understanding poor people's experiences in climate change adaptation in Malawi (ActionAid, 2006), farmers acknowledged their contribution to climate change through degradation of the environment (poor land use and deforestation), which they blamed on lack of livelihood alternatives. They also condemned plantation estates which clear big chunks of

land for agriculture, and suggested development of laws to regulate the cutting down of trees as well as enforce planting of trees by estate owners and communities. Farmers expressed lack of empowerment to speak out to estate owners, and lack of government support in enforcing forest protection laws as key setbacks. However, it should be remembered that the gendered experiences of men and women could imply differences in knowledge, among others (UNDP, 2009). Therefore, in order to effectively influence women's and men's responses to climate change, their knowledge levels and differences should be identified and addressed.

2.2.3 Gender dimensions of perceptions and knowledge of climate change

In studying perceptions of climate change, the aspect of gender deserves consideration on the account that men and women due to gendered experiences may have different perceptions of climate change. Some studies in industrialized countries comparing women's and men's perceptions concerning stressful events have provided evidence of differences in perceptions, with women having higher perception. For instance, Kung and Chen (2012) in a study of perception of earthquake risk in Taiwan found that females reported higher scores on the personal impact of earth quakes than males. Also, in a study on sex differences in the perception of stressful life events in a Spanish sample, it was found that women tended to perceive most stressful life events as more distressing than men. The pattern was particularly salient with the most distressing events, such as sexual abuse, murder, and war. A likely explanation was that as a group, women are much more likely to be the actual or potential victims of some of these events. Thus, they may have a more direct and realistic evaluation of the distressing nature of some of these events. Also, in some instances, previous exposure to trauma may differentially sensitize women, so that in later exposures they are more affected than men (Caballo & Cardefia, 1997).

Furthermore, in a paper to stimulate strategic considerations of women's organizations in Europe, Hemmati (2005) relates women's higher perception of threat to gendered differences in power and control arguing that the less people can impact decisions and strategies regarding a particular issue, the more risky they will perceive the issue. Higher perceptions could also imply that climate change is more likely to be perceived as a problem by women than men. Hemmati (2005) further posits that the differences in perception may consequently result in differences in

plausible responses preferred by men and women, while higher perceptions of women could make them more natural allies in combating climate change.

As noted earlier from the cognitive theory, an individual's behavior concerning a particular event is modified by their beliefs about the event and their assessment of how their behavior will contribute to outcomes in the event that they are able to act. Thus, the impetus for action is linked to a perceived threat and possibility of adaptation (action) to avert the threat, thereby safeguarding what is perceived as valuable, and that the higher the perceived value, the stronger the urge to act. Central to the behavioral response are the elements of threat or risk and opportunities presented by a particular event (Grothmann & Patt, 2003).

It is apparent that there is an appreciable amount of literature in support of the assumption that people who perceive a relatively high likelihood of an adverse event are more likely to take personal ameliorative steps and support government initiatives to do likewise, even in the face of required sacrifice (O'Connor et al., 1999). However, as O'Connor, et al. (1999) note, this assumption had seldom been tested, especially for the case of long-term, uncertain environmental risks such as global warming. O'Connor et al. (1999) further note that while several studies had reported that general environmental beliefs predict behavioral intentions, few had included specific risk perceptions as independent variables (O'Connor, et al., 1999). Thus, in a study on willingness to address climate change the team set out to test the assumption that willingness to support personal and governmental ameliorative behaviors was a partial function of risk perceptions as reflected in (1) expectations that the problem will or is happening, (2) expectations that negative consequences are likely for self and others, and (3) knowledge of the causes of the problem. Using survey data and factor analysis, findings showed that men and older respondents were somewhat more likely to vote for government policies to address climate change than were women and the young. In contrast, they also found that women showed disproportionate support for voluntary actions. They concluded that the findings reflected the tendency for men to feel comfortable with the political world and women to prefer personal approaches to public problems. Furthermore, they determined that knowledge about the causes of the global warming was a powerful predictor of behavioral intentions and that willingness to act was predicted by knowing the causes of climate change (thus, people who think climate change

is an important issue, become informed). These findings provide an important framework for predicating men's and women's behavioral intentions, based on their perceptions of climate change and their knowledge of its causes.

2.3 Climate Change Adaptation in Agriculture

Adapting to climate change is aimed at reducing negative impacts or taking advantage of new opportunities presented by changing climate conditions (IPCC, 2001). Adaptation must also prevent and remove maladaptive practices, that is, measures that do not succeed in reducing vulnerability but instead increase it (UNFCCC, 2007).Some studies have shown that adaptation is indeed vital and beneficial (IPCC, 2007). For instance, in the study on impact of climate change and adaptation on food production in low-income countries carried out in Ethiopia, Yesuf et al. (2008) found that adaptation had not only enabled farmers to cope with the adverse effects of climate change and variability, but also increased the agricultural productivity of poor farm households. Many adaptation actions also have multiple drivers, such as economic development and poverty alleviation, which underlie development policy and planning (IPCC, 2007). This section explores adaptation measures applicable to farmers in Uganda and also characterizes the adaptations to provide a framework and typology for their appraisal and reference.

2.3.1 Adaptation options relevant for Ugandan farmers

Historically, communities in Africa have adjusted to climate shocks, such as floods and droughts, based on their knowledge, norms, beliefs and available resources to sustain their livelihoods. Identifying such measures is the first step in appraising adaptive response (Smit & Skinner, 2002). Hepworth and Goulden (2008) concur that knowledge about how people have responded to past climate shocks such as floods and droughts is useful in understanding how to approach vulnerability reduction or in understanding where adaptation support should be prioritized. The identified possible coping strategies and traditional knowledge then form the basis for local and government interventions (UNFCCC, 2007). From literature, a diversity of climate change adaptations for agriculture have been used, ranging from (i) technological,(ii) behavioral change at the individual level, finance and insurance, to (iii) programmatic interventions at different levels (see Table 1).

Table 1: A summary of adaptation options for common climate change stresses

Climate related stress	Adaptation practices
Droughts	• Traditional rainwater harvesting and small dam construction/water harvesting schemes • Water and soil conservation techniques e.g. Terrace agro-systems • Monitoring of the number of grazing animals and cut trees • Set-up of revolving credit funds • National government programs to re-create employment options after drought • Building shelter-belts and wind breaks to improve resilience of range lands • Capacity building of local authorities • Assistance to small subsistence farmers to increase crop production (Adger et al.,2007) • Intercropping or spatially separated plots for cropping and grazing to diversify exposures • Diversification of income by adding livestock operations • Pruning and fertilizer use • Shifting enterprises e.g. from goat to sheep/from livestock farming to game farming (UNFCCC, 2007) • Shift to drought resistant crops/ change varieties • Change amount of land under cultivation/grazing • Adjustment of planting dates • Irrigation and drainage (Gbetibouo, 2009) • Set-up/provision of crop insurance • Creation of local financial pools (as alternative to commercial crop insurance). • Lowland farming • Accumulation of commodity stocks as economic reserves (IPCC, 2007)
Floods	• Drainage systems • Upland farming • Shift to flood resistant crops/varieties (IPCC, 2007)
Storms	• Participatory risk Assessment and warning system e.g. Radio communication • Construction of cyclone-resistant housing units • Reforestation/afforestation • Building of shelter-belts and wind-breaks to improve resilience of rangelands(IPCC, 2007)

Although insurance measures can be beneficial for many developing countries by transferring climate change risk, the insurance market in such countries is still very limited mainly due to limited economic assets and private sector interest (UNFCCC, 2007). Nonetheless, some plausible cost-effective insurance initiatives for developing countries to help in adaptation to climate change have been suggested (Table 2).

Table 2: Possible cost-effective insurance initiatives for developing countries

• Innovative risk transfer mechanisms such as multi-state risk pooling mechanisms; • Regional reinsurance facilities, either through the private market or from the state, whereby the re-insurer assumes responsibility for covering a portion of the risk, especially for rare but extreme event losses; • Catastrophe funds linked to international financial markets –that pay out on a trigger condition, such as temperatures over a certain value for a certain length of time, rather than on proof of loss; • National/regional disaster funds supported financially by the international community;	• Micro-finance and micro-insurance; • Public-private partnerships • Generation of carbon credits in exchange for support for insurance; • Weather derivatives which provide payouts in response to weather triggers rather than in response to demonstrated losses; • An international insurance pool – payments into an insurance pool would be a form of compensation linked to responsibility or liability for the impacts of climate change.

Source: UNFCCC, 2007

In Uganda, NAPA (2007) based on findings from a Participatory Rural Appraisal (PRA) in 12 districts, identified several coping strategies. Table 3 shows the common agricultural adaptations in Uganda, which were closely similar to those reported in Table 1.

Table 3: Common agricultural adaptation options in Uganda

• Alternative livelihood systems e.g. charcoal burning, brick laying, *bodaboda* • Water harvesting • Change in husbandry practices e.g. adjusting watering and feeding regimes • Self-help initiatives e.g. extended family networks • Increased law enforcement e.g. in preventing poaching and hunting during drought • District disaster management committee • Renting land (may be in the form of barter trade)	• Soil conservation e.g. Coping strategies for soil erosion; landslides and soil degradation is through construction of infiltration ditches around homes; planting grass cover; terrace farming; digging trenches to divert runoff; mulching and tree planting • Bush burning • Shifting cultivation • encroachment on wetlands

Source: NAPA, 2007

Other coping measures not directly related to agriculture include change in eating behavior, hunting of wild birds and animals, migration, famine marriage, sale of assets and use of starter stock, incursions, exploitation of forest and wildlife resources, and idling. As noted by the Uganda NAPA, given the demand to increase adaptation in the country, there is need to document, develop and promote appropriate adaptation strategies in the country.

2.3.2 Characterization of climate change adaptation options

Understanding the basic characteristics of adaptations can go a long way in not only facilitating their appropriate and effective use, but also their linkage with policy and adaptation interventions. As Smit and Skinner (2002) note, identifying and characterizing adaptation options in agriculture is important to understand what types and forms of adaptation are possible, feasible and likely; who would be involved in their implementation; and what is required to facilitate or encourage their development or adoption. This section therefore looks at various parameters from literature that have been used to categorize and assess adaptations. This also forms the basis for developing a generic climate change adaptation appraisal framework and typology for Uganda and similar developing countries.

Adaptations are generally autonomous or policy-driven in association with public agencies (Stern, 2006). Along these lines, adaptation may be classified based on several parameters: spatial scale (local, regional, national); sector (water resources, agriculture, tourism, public health, and so on); type of action (physical, technological, investment, regulatory, market); actor (national or local government, international donors, private sector, NGOs, local communities and individuals); climatic zone (dryland, floodplains, mountains, Arctic, and so on); baseline income/development level of the systems in which they are implemented (least-developed countries, middle income countries, and developed countries); and some combination of these and other categories(Adger et al., 2007).

However, a more functionally useful framework for understanding the different adaptations is provided by Smit and Skinner (2002) in their effort to develop a typology of agricultural adaptation options to climate change for Canada. According to Smit and Skinner (2002), the major characteristics for distinguishing the adaptations are four: intent and purposefulness; timing and duration; scale and responsibility; and form. These are elaborated in Table 4.

Table 4: Characteristics of climate change adaptations

Characteristic	Description
Intent and purposefulness	Intent and purposefulness differentiate between adaptations that are undertaken spontaneously, or autonomously, as a regular part of on-going management from those that are consciously and specifically planned in light of a climate-related risk. Public sector adaptations are usually consciously planned strategies, but private sector and individual adaptations can be autonomous, planned or a combination of the two.

Timing and duration	Timing of adaptation differentiates responses that are anticipatory (proactive), concurrent (during), or responsive (reactive). Duration of adaptation distinguishes responses according to the time frame over which they apply, such as tactical (shorter-term) e.g. within a season (e.g. selling of livestock, purchasing feed and getting a loan) versus strategic (longer-term) referring to structural changes in the farm operation or changes in enterprises or management that would apply for a subsequent season, or a longer term e.g. changes in land use, enterprise mix, crop type or use of insurance.
Scale and responsibility	Adaptations occur at various spatial scales, including plant, plot, field, farm, region and nation, while agents responsible for their development and employment range from individual producers (farmers), agri-business (private) industries to governments (public agencies). Any realistic assessment of adaptation options needs to systematically consider the roles of the various stakeholders.
Form	Here, adaptations are considered according to their administrative, financial, institutional, legal, managerial, organizational, political, practical, structural, and technological characteristics.

Source: Smit & Skinner, 2002

More clarity on timing as a characteristic of climate change adaptations is provided by UNFCCC (2007) which gives examples of reactive and anticipatory responses under agriculture and forestry sectors as highlighted by NAPAs of developing countries (Table 5). Reactive responses are those which are implemented as a response to an already observed climate impact whereas anticipatory responses are those that aim to reduce exposure to future risks posed by climate change.

Table 5: Adaptation measures in agriculture and food security sector

Vulnerable sectors	Reactive adaptation	Anticipatory adaptation
Agriculture and food security	– Erosion control – Dam construction for irrigation – Changes in fertilizer use and application – Introduction of new crops – Soil fertility maintenance – Changes in planting and harvesting times – Switch to different cultivars – Educational and outreach programs on conservation and management of soil and water	– Development of tolerant/resistant crops (to drought, salt, insect/pests) – Research and development – Soil-water management – Diversification and intensification of food and plantation crops – Policy measures, tax incentives/subsidies, free market – Development of early warning systems

Source: UNFCCC, 2007

Rightly so, classifying responses to climate change according to form provides a useful framework for understanding adaptation in agriculture. Thus, Smit and Skinner (2002) combine scale, responsibility and form to constitute a typology with four not-mutually exclusive

categories: (1) technological developments, (2) government programs and insurance, (3) farm production practices, and (4) farm financial management (Table 6). The first two categories are principally the responsibility of public agencies and agri-business, and adaptations included in these categories might be thought of as system-wide or macro-scale. Categories 3 and 4 mainly involve farm-level decision-making by producers. The categories are often interdependent. For example, an adaptation technology developed by government and the private sector (type 1), might be adopted to modify farm production practices (type 3). In another instance, a producer may buy more crop insurance (type 4), when this insurance is supplied or subsidized by government (type 2). Although it is common to include activities, such as, information dissemination and training on climate change and potential impacts aimed at improving general awareness or prompting consideration of adaptations in reviews of adaptation options, these are not direct changes in the agriculture sector or farms within it. The typology instead views such activities as important parts of the means by which adaptation might be encouraged rather than as specific agricultural adaptations in their own right.

Table 6: Types and selected examples of adaptation options in Canadian agriculture

TECHNOLOGICAL DEVELOPMENTS
Crop Development
• Develop new crop varieties, including hybrids, to increase the tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions.
Weather and Climate Information Systems
• Develop early warning systems that provide daily weather predictions and seasonal forecasts.
Resource Management Innovations
• Develop water management innovations, including irrigation, to address the risk of moisture deficiencies and increasing frequency of droughts.
• Develop farm-level resource management innovations to address the risk associated with changing temperature, moisture and other relevant climatic conditions.
GOVERNMENT PROGRAMS AND INSURANCE
Agricultural Subsidy and Support Programs
• Modify crop insurance programs to influence farm-level risk management strategies with respect to climate-related loss of crop yields.
• Change investment in established income stabilization programs to influence farm-level risk management strategies with respect to climate-related income loss.
• Modify subsidy, support and incentive programs to influence farm-level production practices and financial management.
• Change ad hoc compensation and assistance programs to share publicly the risk of farm level income loss associated with disasters and extreme events.
Private Insurance
• Develop private insurance to reduce climate-related risks to farm-level production, infrastructure and income.
Resource Management Programs

• Develop and implement policies and programs to influence farm-level land and water resource use and management practices in light of changing climate conditions.
FARM PRODUCTION PRACTICES
Farm Production • Diversify crop types and varieties, including crop substitution, to address the environmental variations and economic risks associated with climate change. • Diversify livestock types and varieties to address the environmental variations and economic risks associated with climate change. • Change the intensification of production to address the environmental variations and economic risks associated with climate change ***Land Use*** • Change the location of crop and livestock production to address the environmental variations and economic risks associated with climate change. • Use alternative fallow and tillage practices to address climate change-related moisture and nutrient deficiencies. ***Land Topography*** • Change land topography to address the moisture deficiencies associated with climate change and reduce the risk of farm land degradation. ***Irrigation*** • Implement irrigation practices to address the moisture deficiencies associated with climate change and reduce the risk of income loss due to recurring drought. ***Timing of Operations*** • Change timing of farm operations to address the changing duration of growing seasons and associated changes in temperature and moisture.
FARM FINANCIAL MANAGEMENT
Crop Insurance • Purchase crop insurance to reduce the risks of climate-related income loss. ***Crop Shares and Futures*** • Invest in crop shares and futures to reduce the risks of climate-related income loss. ***Income Stabilization Programs*** • Participate in income stabilization programs to reduce the risk of income loss due to changing climate conditions and variability. ***Household Income*** • Diversify source of household income in order to address the risk of climate-related income loss.
Source: Smit & Skinner, 2002

Furthermore, Dolan et al. (2001) provide other relevant criteria for evaluating agricultural adaptation options including economic efficiency, flexibility, institutional compatibility, farmer implementability and independent benefits (Dolan et al., 2001) (see Table 7 for details).

Table 7: Criteria for evaluating climate change adaptations

Criteria	Description
Effectiveness	An adaptation option is viewed as more favorable if it is successful in achieving the objective of reducing vulnerability to climate change risks.
Economic Efficiency	Projects and programs implemented by governments are preferable if they have economic benefits that exceed economic costs.
Flexibility	Flexible adaptation options reduce vulnerability to risks of climate change and

	variability and function in light of a range of climate conditions, not simply a particular projected condition.
Institutional Compatibility	An adaptation option is considered superior if it is consistent with existing laws, regulations and institutional structures, thus adaptation options that are constrained by institutional structures are less preferable.
Farmer Implementability	Relates to the degree of readiness adaptations are taken up in terms of farmer decision-making, technical and managerial ease, and acceptability within existing social norms, the easier they are to implement.
Independent Benefits	An adaptation strategy is viewed more favorably the greater the benefits it brings, apart from (or in addition to) its contribution to reducing/avoiding risk associated with climate change.

Source: Dolan et al., 2001

In respect to the criterion of institutional compatibility, the Uganda NAPA, for instance, categorized the various adaptations found in the country (refer to Table 3) into two categories, A and B. Category A consisted of strategies that generally have positive environmental impacts, are innovative and sustainable, and should be encouraged, while category B consisted of strategies that have either negative environmental impact or distressful physiological effects and should be discouraged. The latter group included adaptations such as bush burning, shifting cultivation and encroachment on wetlands, and alternative livelihood activities such as brick making and charcoal burning.

Several studies on adaptation to climate change, for instance, Ishaya and Abaje (2008) have identified the various adaptation options for agriculture. However, these were listed generically, without providing for the gender dimension. Even recent gendered studies such as the three largely qualitative studies titled "gender and climate change" done by Babugura (2010), Omari (2010) and Ribeiro and Chaúque (2010)in South Africa, Botswana, and Mozambique, respectively, emphasized differential impact and general behavioral changes across various household needs or activities such as water, energy, arable agriculture, and health. For instance, Omari (2010) observed that climate induced poverty and lifestyle changes could force women into risky coping measures such as prostitution to sustain families, while Ribeiro and Chaúque (2010) found that successive droughts had led to an increase in men's migration to South Africa and other places in search for jobs, while women stayed home and carried on both the domestic and productive work. Thus, the studies give limited focus on what men and women are doing differently in climate change adaptation.

2.4 Summary of the Literature Review

The literature explored suggests that various stakeholders given their view point may interpret climate change differently. With regard to perceptions and knowledge, it is apparent that these play an important role in influencing behavioral change and hence, willingness to take responsibility for addressing particular climate change related challenges. There is evidence for differences in perceptions and knowledge of men and women on various aspects, for instance on consequences and causes of climate change, due to differences for instance in their respective values, preferences, experiences and socio-political disposition. Such differences have important implications on how men and women respond to climate change, with women more likely to perceive the world as risky and thus more likely to take precautionary measures. Although the gender variable has been found successful in predicting perceptions and knowledge in the USA for instance, gender studies in developing countries are still limited in quantitative aspects of male and female farmers' perceptions and knowledge of climate change, despite a general trend in the literature suggesting that gender is expected to have an influence on male and female farmers' perceptions and knowledge of climate change. The literature also revealed that men's and women's ability to adapt to climate change is affected by their socio-cultural landscape and as such they are expected to adapt somewhat differently. However, as noted, previous empirical studies on gender and climate change lack specific examples of what men and women are doing differently in terms of adaptations in agriculture. Lastly, the literature explored the various approaches which may be combined to constitute a useful framework for characterizing the different adaptations in agriculture, noting their limited emphasis for gender consideration.

CHAPTER 3: METHODOLOGY

3.1 Research Design

The study utilized both quantitative and qualitative approaches. The study was conducted in two phases: the first phase which was exploratory involved a stakeholder workshop which was conducted on 8th September, 2010 in Soroti district (Eastern Uganda), at Gweri Sub County headquarters. The workshop comprised of 30 participants. These included Community Based Facilitators (CBFs), forestry, agriculture and environment officers from Local Government and Non-Government Organizations (NGOs), Local Council (LC) officials and councilors and male and female farmers in the sub county. The outputs of the workshop included the perceived climatic changes in the area and their effects/impacts, the common adaptation practices used to cope with the respective climate changes as well as the level of effectiveness of the practices as perceived by the farmers. These preliminary findings informed the designing of the quantitative survey tool. The workshop also identified the study sites based on how spread out the adaptation practices were in the sub county. The second phase comprised of a survey conducted in February 2011, in three selected parishes, Dokolo, Awoja and Aukot.

3.2 Description of the Study Area

The study was undertaken in Soroti district (see figure 1), in Eastern Uganda. The district was selected owing to its fragility and sensitivity to climate variability. For instance, Balungi (2010) singled out Soroti district as one of the districts where occurrence of hydro-climatic events such as droughts and floods had markedly increased, causing severe socio-economic impacts that included food insecurity, famine, deaths, epidemic diseases, pests and economic losses. Soroti district lies at 010 46N, 330 39E, in the Kioga plains. The terrain is generally flat, traversed by numerous swamps and other ravine wetlands. Annual rainfall totals are typically 1100-1200 mm distributed between two seasons of March to July and September to November but this has become variable with frequent drought spells causing famine (MWE, 2007).

The soils are of sandy sediments and sandy loams, well drained and highly friable with alluvium deposits in the bottomland. The farming system is predominantly annual cropping and cattle. Small scale farming has been predominant in the area for long, which has greatly reduced vegetation cover, and is suggested to be a likely trigger for negative environmental effects such

as intensity of floods and droughts, soil nutrient and biodiversity loss due to habitat conversion (Majaliwa, 2009).

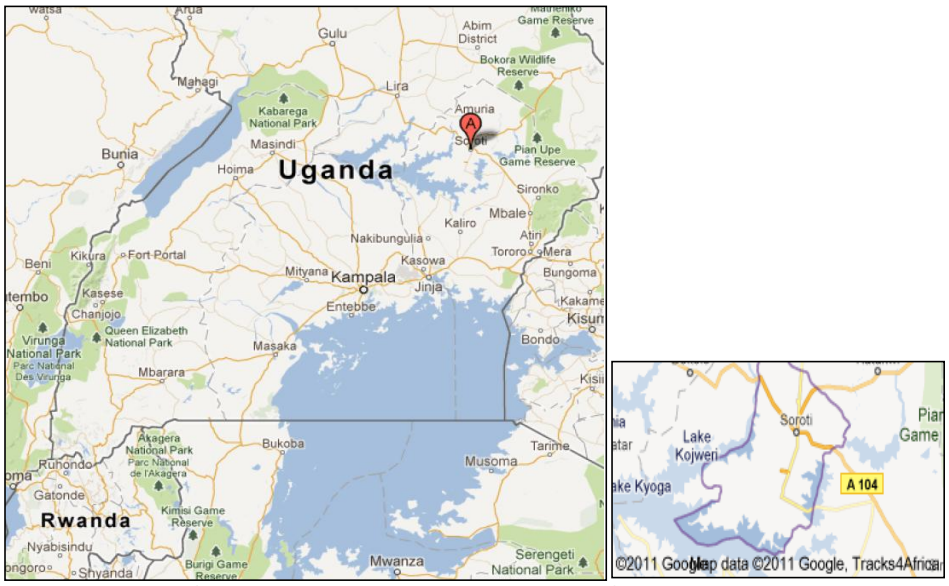

Figure 1Map of Uganda showing the location of Soroti district in Eastern Uganda(Googlemaps.com)

Like most districts in Uganda, agriculture is the main economic activity in Soroti. According to a socio-economic baseline survey of surrounding communities by AmanigaRuhanga and Lyango (2010), food crops and cotton as the main cash crop formed the agricultural base of Soroti. Major food crops included finger millet, sorghum, ground-nuts, cassava, cowpeas, sweet potatoes, maize, soy beans, simsim (sesame) and sunflower, while major fruits and vegetables included passion fruits, oranges and mangoes, tomatoes, onions and cabbages. From the survey it was also apparent that rural communities are heavily dependant on wetlands. The farming households, cattle keepers and beekeepers attached a lot of importance to wetlands in terms of provision of water, pasture and other ecological functions that facilitate the survival of life. The growing of rice, cassava, sweet potatoes, millet and sim-sim, ground nuts, cow peas and beans as well as cattle keeping was all wetland supported especially during the long dry seasons that affect the region. As such, AmanigaRuhanga and Lyango (2010) noted that climate change had increased pressure on wetlands as people desperately turn to them for moist and fertile lands for crop

growing. They further note that although both men and women exploited wetlands in Soroti, men's nature of interface with the ecosystem, for example, in brick making, charcoal burning and bush burning for pasture raises some ecological concerns.

By 2010, Soroti was home to 445,800 people (228,000 female, 217,800 male) (AmanigaRuhanga & Lyango, 2010). According to Isubikalu (2007), the district is mainly dominated by the Iteso ethnic group, and communities there are largely patrilineal, whereby women, and other forms of assets like land are considered as men's property and male domination in decision making is a well-established norm. Women are cultured to be submissive and obedient to their husbands. Instances of female subordination have manifested in the inheritance of women and giving of women as compensation for crime as property, out-marrying girls for wealth gain and preference for male child education. It is thus not surprising that men and women are expected to perform different roles in community, with men expected to provide financial requirements for the home, while women are expected to provide food for the household. Table 8 shows distribution of activities by gender in Soroti district. Furthermore, social bonds in the community are largely based on ties of socialization, labor, income generation and moral support (Isubikalu, 2007).

Table 8: Distribution of activities by gender in Abuket village, Soroti district (Adapted from Isubikalu (2007)

Activity	Men (%)	Women (%)
Land preparation		
• Ploughing with oxen	80	
• Slashing (mainly for cash)		
Buying sauce (meat & fish)	20	
Caring for the home e.g. fetching firewood & water, caring for children and the elderly, cooking, etc.		90
Meeting medical & educational bills	90	
Looking after cows	80	
Ensuring security at home	85	
Farming for income generation	95	20
Farming for home consumption	30	100
Looking after small ruminants & poultry		40
Post-harvest handling		90
Petty business or trade	30	20
Drinking local brew	50	30
Participating in groups & community activities		40

3.3 Population and Sampling

According to UBOS (2011), the average number of households per parish in Gweri Sub County was estimated at 623 households, making an average population of 1869 households in the three parishes. Therefore, given a 5% error margin, the estimated sample size for three parishes is 319 households. However, the resources available for the study could only allow for about 150 households, which is about half of the estimates sample. The study sample comprised of male and female headed farming households in Gweri Sub County. The targeted sample size was 150 households, comprising of 50 households from each of the three selected parishes as identified in the exploratory workshop, including Dokolo, Awoja and Aukot, based on how spread out the common adaptation practices were in the sub county.

After data cleaning, data from only 135 households were used in the analysis as 15 questionnaires were dropped on account of incomplete and/or inconsistent data. These constituted 90 male and 45 female-headed households (Table 9).Stratified random sampling was employed to ensure that both male and female headed households were well represented in the sample given the importance of household headship in the study. This was necessary because female headed households were found to be fewer compared to male headed households. Accordingly, all female headed households that could be accessed were included by default, while male headed households in the three parishes were randomly selected from a sample frame of 300 male headed households generated by the Community Based Facilitators of the respective parishes.

Table 9: Study sample size

Parish	No. of male headed households	No. of female headed households	Total
Dokolo	22	14	36
Awoja	30	19	49
Aukot	38	12	50
Total	***90***	***45***	***135***

3.4 Development of Data Collection Tool

The agenda for the exploratory workshop was developed and agreed upon with supervisors. On the other hand, quality of the interview schedule was ensured by a panel of experts (Appendix 2)

who reviewed the instrument to guarantee that the data obtained would address the objectives of the study. Prior to administering of the tool, it was pretested for suitability. After the pretest, some modifications, such as, removal of repetitions and unnecessary questions were made in order to make the schedule more user-friendly.

3.5 Data Collection Methods and Procedures

The exploratory workshop was facilitated by Dr. Christopher Bukenya to ensure quality of outputs. For the household survey, an interview schedule (Appendix 1) was used to collect data. Data were collected at household level as well as individual level so as to enable comparison at both levels, that is, between men and women and across male and female headed households especially in regard to adaptation practices. The schedule was administered by five trained enumerators after pretesting in a village near the study area to provide for reliability in data collection. Fluency in the local dialect (Ateso) was a requirement during recruitment of enumerators so as to ensure quality data collection and recording. In addition, team debriefs especially at the outset of the data collection exercise were held to share lessons and challenges so as to ensure that the enumerators had good understanding of the instrument. Identification of respondents was done with the help of community based facilitators in the respective parishes sampled.

Temperature and rainfall data for Soroti district were also obtained from the Department of Meteorology, Ministry of Water and Environment to enable comparison between farmers' perceptions and the climate data. Other data were obtained from key informants, including male and female farmers, government and NGO technical staff and local leaders through the plenary and group discussions conducted in the stakeholder workshops.

3.6 Data Analysis

Survey and meteorological data were entered in SPSS computer program and cleaned. Resulting data were then analyzed using SPSS and Excel programs. Analyses specific to the respective study objectives are summarized in Table 10.

Table 10: Summary of analyses by study objective

Objective	*Specific analyses*
Objective 1:*Farmers' perceptions & knowledge*	• Perceptions of changes in climate measured in percentages based on 11 parameters (Ishaya & Abaje, 2008) were used to measure farmers' perceptions of climate change. Responses to changes included; Agree (1) disagree (0). Farmers' perceptions of climate changes compared with temperature and rainfall data (Gbetibouo, 2009) • Temperature and rainfall trend analysis over the 30 year period analyzed using linear regression (Remy et al., 2005). • Percentages also used to analyze perceptions on the future of climate change based on whether effects were expected to (get worse, better, don't know); whether something could be done to change the situation (yes, no); and the explanations why nothing could be done. • Two-proportion z-tests were also used to assess differences in percentage proportions. • Descriptive statistics, including means and percentages were used to assess men and women's access to and control of key assets as well as access to services • Paired and unpaired t-tests were used to assess differences in the continuous variables
Objective 2: ***Determinants of knowledge of climate change***	• Multinomial logistic regression used to identify the determinants of knowledge of the cause of climate change across male and female household heads $Y_i=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5\ldots\ldots$ (1). Multicollinearity among independent variables was tested (Leech, *et al*. 2005). Four independent variables that had tolerance values greater than $1\text{-}R^2$ (1-0.084 = 0.916) were included in the model (see Appendix 3). The resulting model (Table 19) significantly predicted knowledge of climate change cause ($\chi^2 = 18.455$, df = 8, p = 0.018). The dependent variable categories were; don't know (1), wrong (2) and correct (3). The independent variables included gender of household head, age of household head, access to extension services and access to credit services. The regression compared respondents who did not know the cause of climate with those who were right; and those who were wrong with those who were right. (see Table 11 for explanatory variables and the expected sign for knowledge).
Objective 3:*Characterization of farmers' adaptations*	• Percentages used to assess distribution of crop and livestock adaptations • Chi-square used to test the relationship between gender (male and female headed households) and adaptations practices • Adaptations characterized based on various parameters outlined by Dolan *et al*. (2001), NAPA (2007) and a typology of climate change adaptations developed by Smit and Skinner (2002) in the case of Canadian agriculture.
Objective 4:*Household members' contribution to adaptation*	• Percentages were used to analyze women and men's contribution to household adaptation • Lastly, a Chi-square test was run to test the relationship between gender (men and women) and adaptation farmer actions (decision making, planting, weeding, harvesting and selling of proceeds).

Table 11: Description of explanatory variables and the expected sign for knowledge

Variable	Description	Expected sign	Reason
X_1	Gender of household head: female=1; male=0	-	Female heads have less opportunities for exposure to information
X_2	Access to credit: yes=1; otherwise=0	+	Individuals invest in agriculture and are keen on changes that affect productivity
X_3	Access to extension services:yes=1; otherwise=0	+	Individuals have access to information on changes affecting agriculture and how to respond
X_4	Age of household head	+	Older farmers have more experience and accumulation of knowledge
X_5	Education level (years of schooling)	+	More education favors faster knowledge acquisition

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Male and Female Farmers' Climate Change Perceptions and Knowledge

This section presents findings on farmers' perceptions of climate change followed with a comparison of the farmers' perceptions with meteorological data, farmers' perceptions of the future and, lastly, an assessment of men's and women's knowledge of climate change.

4.1.1 General perception of climate changes

Participants in the stakeholders' workshop concurred that the major climate change events in the past 10 years were flood, drought and strong wind and storms. Major flood incidents were reported to have occurred in 1976, 1996 and 2007; with the 2007 being the most severe. On the other hand, drought was reported to have occurred in 1944, between 1992 and 1994, and between 2008 and 2009; with the 1944 drought being the driest, while the 2008- 2009 drought was the longest, lasting four months. Higher temperatures had been observed overtime as well as incidents of strong wind and storm during dry seasons and following the flood.

Quantitative data from the survey to explore the extent to which farmers believed the identified climate events had become more intense or increased in frequency over time generally revealed high perception of change across the parameters. For instance, all male and female respondents agreed that the climate was changing (Table 12). On examining the proportions of men and women perceiving changes by climate change parameter, it was found that although the proportions were close most of the time, women were more likely to perceive the changes. This was particularly so for perception of increased frequency of droughts as revealed by the two-proportion Z-test ($z(127)= -2.6916; p<.0.007$).These findings suggest that men's and women's beliefs about changes in climate were generally similar.

Findings on farmers' perceived climate changes were in agreement with previous studies in Uganda and elsewhere. For instance, a study by Oxfam (2008) in Bundibugyo and Kasese districts also revealed increased frequency and intensity of droughts, heavy rains, floods, and erratic rainfall. Similarly, in a study on indigenous people's perception of climate change and adaptation strategies in Nigeria Ishaya and Abaje (2008) found that the majority of the respondents (86%) thought that the environment had been changing over the years.

Table 12: Farmers' perceptions of climate changes over the past 30 years

Climate change parameters	Agree (%)		Z-values	p-values
	Women	Men		
Climate changes generally noticed (n=132)	100	100		
Temperature increased (n=133)	97	97	-0.107	0.9124
Temperature decreased (n=132)	57	52	-0.4356	0.65994
Rainfall decreased (n=132)	93	92	-0.1497	0.88076
Length of seasons changed(n=133)	97	95	-0.5766	0.56192
Floods more frequent (n=122)	89	85	-1.5015	0.13362
Floods more severe (n=120)	94	95	0.2082	0.83366
Droughts more frequent (n=127)*	97	83	-2.6916	0.00714
Droughts more severe (n=119)	95	91	-0.856	0.38978
Strong winds more frequent (116)	77	75	0.1199	0.90448
Strong winds more severe (n=111)	64	65	0.3666	0.71138

% within sex of the respondent; * significant at $\alpha = 0.05$

Similarly, Gbetibouo (2009) in attempting to understand farmers' perceptions and adaptations to climate change and variability in Limpopo basin, South Africa found that most of the farmers (91%) perceived the temperature in the Limpopo Basin to be increasing. Also Nhemachena and Hassan (2007) in a study involving micro-level analysis of farmers' adaptation to climate change in Southern Africa concluded that farmers were aware that the region was getting warmer and drier with increased frequency of droughts and changes in the timing of rains. In Northwestern India, a study by Vedwan (2006)on local knowledge and perception of climate change found that apple growers perceived reduced snowfall and changed timing, with more than 85 percent of the informants believed that the timing of snowfall had changed.

4.1.1.1 Farmers' perceptions versus meteorological data

Temperature and rainfall data are presented in Figures 2 and 3, and the trend linear regressions in Tables 13 and 14, respectively. The missing data for annual mean and maximum temperatures between 1985 and 1990 were due to technical constraints experienced at the Soroti weather station. The average annual temperature data exhibited a positive trend, suggesting a 0.69^{o}C increase in temperature over the 30 year period. As seen in Table 12, equal proportions of men and women (97%) were in agreement with this trend. On the other hand, although the analysis for the rainfall data showed that the amount of rainfall received annually had reduced by about 20mm over the period, the trend was not statistically significant at ($P<0.05$) and the R^2(0.043) was very low meaning that variations in rainfall could not be explained by the time variable

alone. This was in spite of the claim by about 92% of both men and women that rainfall in the area had declined. This provides further evidence that farmers' perceptions tend to be influenced by recent occurrences which may not necessarily depict reality. Maddison (2007) made a similar observation based on findings from a survey of agriculturalists in 11 African countries. Also, farmer perceptions in this regard are more likely to be shaped by rainfall distribution rather than total amounts of rain received over the year given the low adoption of water harvesting technologies. Generally, the findings reveal that men and women's perceptions with regard to rainfall and temperature varied only marginally and may not necessarily agree with analyses from meteorological data. This points to a need to harmonize farmers' perceptions with scientific data. Meteorological data can be suitably packaged to sensitize farmers about climate change indices so as to dispel misconceptions arising from their subjective perceptions.

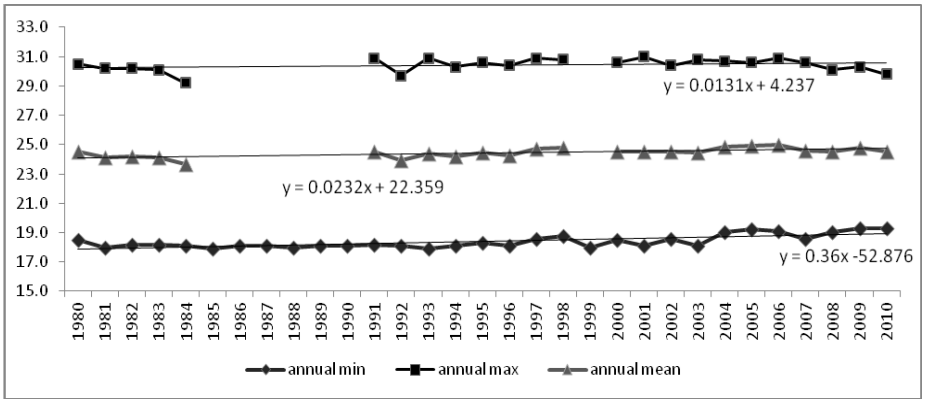

Figure 2 Trend of mean annual temperature for Soroti district in Uganda between 1980 & 2010

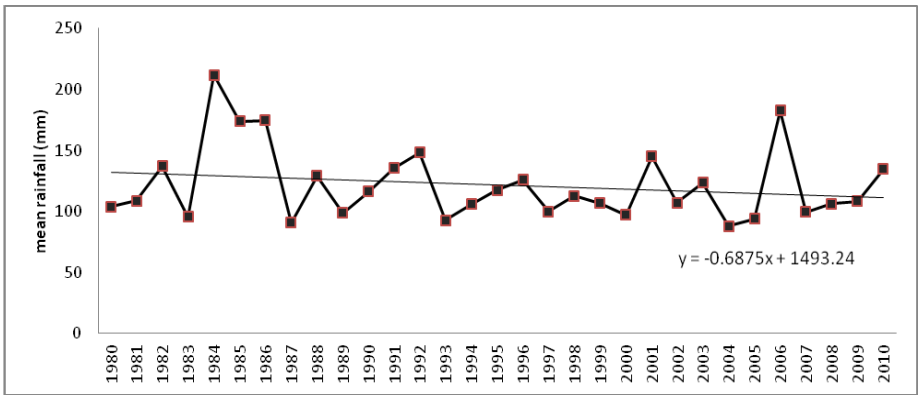

Figure 3 Trend of mean annual rainfall for Soroti district in Uganda between 1980 & 2010

Table 13: Regression analysis of annual mean temperature from 1980 to 2010 for eastern Uganda

	Constant	R^2	Coefficients (B)	t-values	Std. Error
Temp. (max)	4.327	0.078	0.013	1.363	0.010
Temp. (mean)	-22.359	0.472	0.023	4.435**	0.005
Temp (min)	-52.876	0.56	0.36	-5.967**	0.006

**Significant at α = 0.01

Table 14: Regression analysis of mean annual rainfall from 1980 to 2010

	Constant	R^2	Coefficients (B)	t-values	Std. Error
Mean annual Rainfall (mm)	1493.24	0.043	-0.688	-1.138	0.604

4.1.1.2 Farmers' perceptions on the future of climate change

The majority of respondents (63% of men and 53% women) expected climate change effects to become more severe, while about 23% were optimistic that things would get better. On the other hand, about 14% men and 24% women could not give an impression of what the future would be like (Table 15).

Table 15: Perceptions of farmers on what the future holds

	Sex of the respondent		
	Male% (n=63)	**Female% (n=69)**	**Total%(n=132)**
Don't know	14	23	19
Better	23	24	23
Worse	63	53	58
Total	100%	100%	100%

A two-proportion Z-test ($z(135)=\pm4.72$, $p<.0001$) confirmed that respondents who thought things were bound to get worse were significantly more than those who either thought things would get better or those who could not tell what they expect the future to be like. Thus, there were more people who expected climatic change consequences to get worse. This view resonates with the recent scientific prediction of future climate change according to the IPCC (2007) synthesis report which states that continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century. However, the Chi-Square test to determine the relationship between gender and respondents' perceptions on whether in future the climate change situation would get better, worse or don't know, was not

significant ($\chi^2 = 3.634$, $df = 3$, $p = 0.304$) implying that both men and women held similar views on this.

On the other hand, although the majority of respondents expect worse climate change consequences in future, most of the farmers (81% men and 74% women), had hope that something could be done to reduce the future burden of climate change. Only 23% were pessimistic that something could not be done (Table 16).

Table 16: Perceptions of farmers on reduction of the effects of climate change

	Sex of the respondent		
	Male% (n=62)	**Female% (n=69)**	**Total%(n=131)**
No	19	26	23
Yes	81	74	77
Total	100%	100%	100%

Also, a two-proportion Z-test ($z(135)=\pm 7.39$, $p<.0001$) confirmed statistically significant differences between the two proportions, implying that more farmers thought something could be done about the situation. This notion is also held in the science realm that societies can indeed respond to climate change by adapting to its impacts, thereby reducing the rate and magnitude of change (IPCC, 2007). The Chi-Square test for the relationship between gender and perceptions regarding whether or not something could be done to avert climate change was not significant ($\chi^2 = 0.838$, $df = 1$, $p = 0.360$).

Furthermore, farmers who believed nothing could be done about the situation of climate change were requested to explain their pessimistic stance. A summary of the explanations is provided in Table 17.

Table 17: Explanations for pessimistic views on the future (n=25)

Response	Men (%)	Women (%)	Overall (%)
1. End of the world/God's wrath	50	46	48
2. No good will from people to change practice	34	38	36
3. Corruption of leaders/officials	8	16	12
4. Limited livelihood options	8	0	4
	100%	100%	100%

According to these results, most of the people (48%) view climate change as an external force against which they find themselves helpless. On the other hand, the laxity to adopt better

practices, corruption of leaders/officials and limited livelihood options are genuine challenges whose remedies lay in the hands of community members, government and other development agencies.

The above findings of farmers' perceptions on the future of climate change show that a majority of respondents expected climatic change consequences to get worse, but also that a majority of farmers hold the belief that something can be done for better. Both of these sentiments are also widely held in the scientific circles. Encouragingly, however, we find that the optimist group is larger than the pessimist group. The two groups represent both an opportunity and challenge for climate change adaptation programs/initiatives. The opportunity is presented by the momentum within the community by the optimists to facilitate the adaptation process, for instance, by actively pursuing and seizing opportunities to get out of undesirable situations. As Rosenstock et al. (1988) note, people tend to act if they realize that their actions positively affect outcomes. This momentum should be practically tapped into, for instance, through improved service delivery, identifying and supporting farmers who are quick to take up adaptation practices so as to act as models for others and promoting rural entrepreneurship. Members of the optimistic group could be especially critical for leadership in steering climate change response.

On the other hand, the pessimists who mainly manifested a helpless attitude in the face of climate change may continue to frustrate adaptation efforts and even weaken the community adaptation momentum. As Rosenstock et al. (1988) further note, individual behavior is also determined by self-efficacy, that is, one's own competence to perform the behaviors needed to influence outcomes. Therefore, if farmers continue to see that the locus of control on issues pertaining to climate change lies beyond them, they may retreat, sit and wait for their fate. For instance, Adger et al. (2008) noted that if the possibility of a threshold being reached, and the system changing to a different state as a result, is perceived as unattainable through a particular individual or societal lens, this perception would identify this threshold as a limit to adaptation.

In regard to optimism and pessimism in view of the future of climate change, we find that both men and women respondents held more or less the same outlook. Thus, adaptation interventions aimed at influencing farmer perceptions on the future of climate change can adopt the same message for men and women. However, such interventions need to take into account the

existing optimist-pessimist dichotomy in perceptions and aim at empowering both men and women from both camps as active agents of climate change adaptation.

4.1.2 Farmers' knowledge of climate change

4.1.2.1 Causes of climate change

Farmers perceived climate change to be caused by a range of factors. The respondents were clustered into three categories; those in agreement with scientific empirical understanding (for example as explained by Pidwirny (2006) and IPCC (2007) (category 1), those in contradiction to this (category 2) and those who didn't know the cause (category 3). Category 1 was regarded as correct according to the scientific world view while category 2 was regarded as wrong. Farmer responses in category 1 included destruction of vegetation/trees, poor farming practices and encroaching wetlands while category 2 responses included super natural forces/God, seasonal changes and change in wind direction (Figure 4).

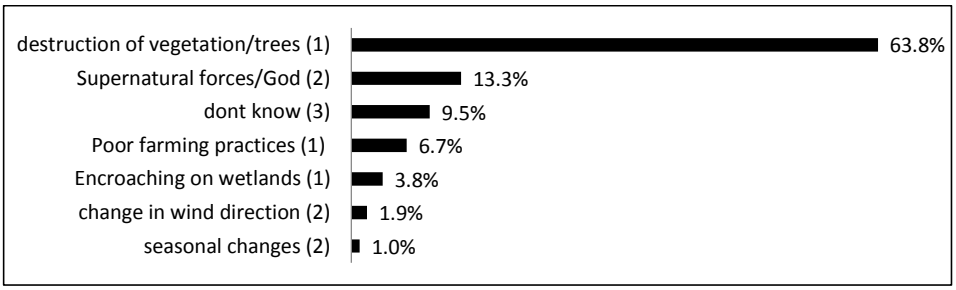

Figure 4 Farmer perceived causes of climate changes in Eastern Uganda (%) (n=105)

According to Pidwirny (2006) and IPCC (2007)'s understanding of the causes of climate change, about 74% of respondents knew the correct cause of climate change (that is, about 90% of men compared to only about 60% of women) while about 16% held a contradictory view (about 27% of women compared to only 6% of men). Furthermore, only about 4% of the men reported that they did not know the cause of climate change compared to about 14% of women. The findings show that although the majority of the farmers were knowledgeable about the cause of climate change, men were more knowledgeable compared to women, with the Chi-square test showing a significant relationship between gender and climate change knowledge among respondents ($\chi^2 =$ 12.761, $df = 2$, $p = 0.002$). However, the results also reveal a divide among respondents in regard

to those who believe that climate change is due to destructive human activities and those who believe otherwise. Those who consider human activities to have little or no influence constitute a sizeable proportion. One implication is that people who know that climate change is caused by human actions are more likely to adopt climate change adaptations than those who feel otherwise. This points to the need for sensitization of communities about the causes of climate change and possible remedies. This is especially so for the women who appear to be worse off than men.

4.2 Determinants of Climate Change Knowledge among Male and Female Farmers

According to results from the multinomial logistic regression (Table 18), only sex of the household head was found to significantly predict farmers' knowledge on climate change causes.

Table 18: Analysis of determinants of farmers' knowledge of the cause of climatic change

		B	Std. Error	Wald	Sig.	Exp(B)
Don't know	Intercept	-3.466	1.564	4.910	.027	
	sex_head	2.360	.797	8.764	.003**	10.588
	age_head	-.012	.030	.159	.690	.988
	access_extn	.760	.785	.939	.333	2.139
	access_credit	.838	.750	1.249	.264	2.311
Wrong	Intercept	-2.812	1.085	6.712	.010	
	sex_head	.976	.564	2.994	.084*	2.655
	age_head	.029	.020	2.039	.153	1.029
	access_extn	-.357	.555	.414	.520	.700
	access_credit	-.544	.637	.728	.393	.581

Model Fitting Information					**Pseudo R-Square**	
Model	Model Fitting Criteria	Likelihood Ratio Tests			Cox and Snell	.161
	-2 Log Likelihood	Chi-Square	df	Sig.	Nagelkerke	.207
Intercept Only	150.538				McFadden	.117
Final	132.083	18.455	8	.018		

a. The reference category is: correct **Significant at α = 0.01; *Significant at α = 0.1

Female heads were close to eleven (11) times more likely to be ignorant about the cause of climate change and they were also about three (3) times more likely to be wrong about the cause

of climate change than their male counterparts. This underlines the gap between male and female farmers' knowledge of causes of climate change. This gender gap could be due to differences between men and women in education levels, access to agricultural information sources such as extension, radio and membership to farmer organizations. The survey established that female household heads were significantly less educated than male heads ($t(133)=5.607$, $p<.001$).The mean number of years of schooling of female heads ($\bar{x}=3.2$, $\sigma=3.2$) was only half that of the male heads ($\bar{x}=6.7$, $\sigma=3.4$).

Wolfe and Haveman (2002) make a case for social and nonmarket benefits from education highlighting empirical evidence of positive contributions of more schooling. For instance, more schooling was seen to be helpful in reducing pain, suffering and anxiety in response to negative life events as well as reduction in mortality. It was also found to boost savings and social cohesion in addition to facilitating technological and social change. More schooling also helps people to make more informed choices, participate more fully in their communities and increases the probability of nonviolent protests against government-sponsored repression. Consequently, educational differences are likely to leave women disadvantaged and less influential in communal endeavors.

Table 19: Access to services by gender of household head

Services		Male-headed households (n=90)	Female-headed households (n=45)	χ^2	*df*	P-value
Access to extension services (n=135)	No	40%	60%	4.821	1	0.028
	Yes	60%	40%			
Membership to farmer organizations (n=135)	No	48%	69%	5.398	1	0.020
	Yes	52%	31%			
Access to radio (n=134)	No	27%	61%	15.092	1	0.000
	Yes	73%	39%			

Furthermore, chi-square tests confirmed differences in access to extension services, farmer organizations and radio between female-headed households and male-headed households (Table 19).For instance, access to extension services by female-headed households (40%) was

significantly less than that by male headed households (60%). It is widely believed that limited mobility, access to resources especially land, excessive workloads and high illiteracy relative to men dampen women's opportunity to participate in extension programs (World Bank, 2009).

In addition, access to farmers' organizations by female headed households (31%) was also significantly less than that for male headed households (52%). Female headed households therefore miss out on known opportunities of organized groups to access benefits such as savings and credit, enhancing common property management of natural resources, advancing claims to rights and resources, overcoming market failures in addition to providing an important forum for women to access and share information (World Bank, 2009).

Access to radio was also significantly less for female headed households (35%) compared to male headed households (73%). Being the main traditional medium used in disaster management and given high illiteracy, radio remains the most frequently used, most publicly accessible medium to the poor, especially women as well as and most effective medium (Yap, 2011). With radio being a key medium of information especially to the poor, this unequal distribution of radio amongst male and female headed households suggests that women especially in female headed households are less likely to receive guidance on coping with climate change.

This particular result strongly highlights an important gender implication in charting the way forward on climate change response by men and women. Since men and women are at different levels of knowledge at least in initial discourse, with women more likely to have either false knowledge or ignorant about the cause of climate change, a gender sensitive approach is essential. Moreover, with societies being largely patriarchal, where men dominate decision making (Moser, 1993), women's interests and ideas or concerns are more likely to be left out of the mainstream. In other words, Leiserowitz (2005) cautions that since negotiations are often an exercise of power, with the powerful having the upper hand to determine outcomes, taking care to embrace the multiple voices and perspectives in community is necessary as the solution rests in the coordinated action of all.

4.3 Characterization and Evaluation of Farmers' Climate Change Adaptation Strategies

This section handles farmers' climate change adaptation actions commonly used in Soroti district. Firstly, the section takes stock of the common adaptation practices employed under crop and livestock enterprises and their distribution. This is followed by gender analysis of the practices and later, an evaluation of the adaptation practices is done using several key criteria drawn from Dolan et al. (2001) and Smit and Skinner (2002).

4.3.1 Climate change adaptation practices in Soroti

A total of about 76% of households (77% male and 73% female headed) had made adjustments in their farming practices due to a perceived climate change event, namely, droughts, floods, and strong winds/storms in either crop or livestock production. Generally, adaptations were mostly linked to drought, and in particular, crop enterprises. As demonstrated in Table 20, households adapting to increases in drought, floods and strong winds under crop enterprises were 64%, 36% and 16%, respectively, while those adapting under livestock were 20%, 6% and 3%. Only marginal differences were observed between male and female headed households. The higher level of adaptation within crop enterprises as compared to livestock enterprises is probably due to relative costs and production intensities associated with the two categories of enterprises.

Table 20: Households adapting to climate changes under crop and livestock enterprises (n=102)

Climate event	Crop enterprises			Livestock enterprises		
	Sex of household head		Overall	Sex of household head		Overall
	Male	Female		Male	Female	
Drought	62%	67%	64%	20%	18%	20%
Floods	38%	33%	36%	6%	6%	6%
Strong winds	17%	12%	16%	3%	3%	3%

Among the adapting households, the adaptation practices amounted to 10 under crop enterprises and eight under livestock enterprises (descriptions and distribution of the respective practices are displayed in Tables 21 and 22).

Table 21: Description of crop enterprise adaptation practices and their distribution (n=88) (HH=headed household)

Adaptation practice	Description	Male HH (%)	Female HH (%)	Overall (%)
1. Timely planting	Early planting is usually done for groundnuts, cowpeas and cassava. Farmers ensure that crops maximize seasonal rains by preparing their gardens early so that they can be able to plant as soon as they are confident about the rains, based on farmers' assessment of the trends. As such, planting dates change accordingly.	29.0	28.6	29
2. Improved varieties	New varieties developed for hardiness and high yield are adopted, for instance, Serenut II (groundnuts) known for drought tolerance.	20.4	31.0	23.7
3. Introduction of crops not originally grown by household	New crops with certain attributes are taken on. These included fast maturing crops e.g. cowpeas and sorghum which help to offset food shortage after floods or in anticipation of drought, strong winds or floods; crops with high tolerance to respective climate condition e.g. paddy rice which does well in floods.	17.2	7.1	14.1
4.Diversification & intercropping	Crop diversification is done to reduce risk due to climate conditions e.g. maize & ground nuts intercrop. Farmers also try to diversify their incomes by doing enterprise mix (e.g. goat, apiculture, poultry) or engaging in off-farm work such as business.	11.8	11.9	11.9
5.Low/upland cultivation	Shifting cultivation to higher altitude areas or balancing between lowland and highland farm activities is done to reduce risk. Farmers also try to avoid growing perennial crops e.g. citrus and mangoes in flood prone areas. It also involves growing crops in swampy areas.	6.6	14.0	8.9
6.Tree planting	Trees e.g. malahina (*Gibrellina arborea*), mangoes, eucalyptus and oranges are planted to act as wind breaks and to provide food and alternative income. Tree systems include woodlots, boundary trees, compound trees, and tanduya system (trees & crops).	6.5	2.4	5.2
7.Irrigation	Involved the use of mineral water bottles and triddle water pumps. Irrigation is usually done for high values crops e.g. oranges, cowpeas, tomatoes, other vegetables.	3.2	2.4	3.0
8.Water ways/diversion channels	Involves making waterways to direct water away from gardens so as to avoid erosion of farm soil and destruction of crops. However, during intense flooding the channels are rendered ineffective.	3.3	2.4	3.0

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9.Early harvesting & storage	Avoids total loss from floods or strong winds in case of cereals e.g. maize, rice. Harvesting and drying of cassava and sweet potatoes using tarpaulins, raised grounds e.g. roofs and rocks is done early and produce is stored in raised, water proof granaries.	1.1	0.0	0.7
10.Crop rotation	A soil fertility conservation technique which involves seasonal changing of crops grown on a piece of land.	1.1	0.0	0.7

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Table 22: Description of livestock enterprise adaptation practices and their distribution (n=20)

Adaptation practice	Description	Male HH (%)	Female HH (%)	Overall (%)
1. Use of better adapted species	Farmers change from more vulnerable animal species to those which are more enduring in face of climate changes. For instance, some were taking on bee keeping as an alternative enterprise. Others were opting for the smaller animals such as goats, chicken and pigs which are easier to feed in the tough times.	45.0	33.3	41.4
2.Changing grazing area	Herdsmen move cattle from areas severely affected by either floods or drought to find water and pasture.	15.0	22.2	17.2
3. Watering of animals	This involved fetching water for animals such as cattle and goats when nearby communal watering points were dry or when it was thought risky to leave the animals to go out during floods for fear of drowning or injury.	5.0	22.2	10.3
4.Supplementary feeding	Improved pastures and silage were used in feeding cattle and goats during the harsh conditions of drought and floods.	15.0	0.0	10.3
4.Vaccination	Helps to boost the health of animals and thus their resilience in climatic hardships.	10.0	0.0	6.9
6.Mixed farming	A diversification measure to cushion farmers' incomes given the climate change risks at hand	0.0	22.2	6.9
7.Change animal breeds	Some farmers sold off a number of local animals, taking on improved breeds such as Friesian cows and Boer goats, which have better performance.	5.0	0.0	3.4
8.Restriction of animals	Here, animals were tied on ropes or enclosed so as to limit their movement especially during conditions of strong winds/storms in order to avoid injury and straying of animals.	5.0	0.0	3.4

Notably, use of improved varieties, early planting, and introduction of crops not originally grown by a household were the most widely used adaptations on crop enterprise, while changing animal species, changing of grazing area and watering of animals were the most popular amongst animal enterprises. Here, we see a clear contrast in the distribution of improved crop varieties (24%) and

improved animal breeds (just over 3%) which can be explained by the relative costs involved (see Table 21& 22).

The above results indicate that there was varied adaptation response by farmers across climate change events and enterprise categories, with drought and crop enterprises showing higher responses. Participants in the exploratory stakeholders' workshop pointed to low access to improved technologies, especially improved crop varieties and animal breeds, in addition to their associated high management costs. They argued that in many cases such technologies were more accessible by those farmers who had access to external support from programs or projects such as those under NGOs.

4.3.2 Gender analysis of the adaptation practices

Findings from the exploratory stakeholder workshop pointed to the likelihood of differences in choice of adaptation options between men and women. For instance, specialization in flood tolerant crops such as paddy rice tended to be more popular amongst men because it was considered labor intensive. Women on the other hand were reported to be more involved with growing food crops in swampy areas, early maturing crops, and silage making. However, this trend was not supported by the quantitative data showing the distribution of adaptation practices between male and female headed households (Table 23**)**. The Chi-square test to determine the relationship between gender of household head and the utilization of the three most popular drought adaptation practices for crop enterprises was not significant ($\chi^2 = 0.347$, $df = 1$, $p = 0.556$). This suggests that distribution of adaptation practices across male and female headed households was similar. Nonetheless, it is noted in Table 23thatno female headed households were utilizing the tree planting, up/lowland shifting cultivation and crop rotation as adaptation practices.

Table 23: Distribution of adaptation practices across male and female headed households

Adaptation	Male headed households (%) (n=55)	Female headed households (%) (n=27)
Timely planting	31	29
Using improved varieties	27	37
Changing planting dates	9	4
Use of new crop species that are better adapted	11	11
Irrigation	5	4
Crop diversification	7	11
Intercropping	2	4
Up/lowland shifting cultivation	4	.0
Tree planting	2	.0
Crop rotation	2	.0
	100%	100%

The above finding may be related to the gender related restriction of control and ownership of land by women since such adaptation options would require considerable amounts of land and or some control over the land. Table 24 clearly shows that women had absolutely no independent control of land while men had about 53% control, whilst with the remaining control mainly under clans. The data also shows low control of key agricultural assets like ox-ploughs and spray pumps by wives and other household members which disadvantages them in pursuing strategies such as early planting especially where labor is limited.

Table 24: Control of land and other key assets (n=132)

Asset	Husband (%)	Wife (%)	Both (husband & wife) (%)	Other* (%)	Total (%)
Land	53	.0	10	37	100%
Ox-ploughs	71	.0	23	6	100%
Radios	70	3	27	.0	100%
Phones	62	6	23	9	100%
Bicycles	70	4	25	1	100%
Spray pumps	82	.0	14	4	100%

* Other includes; clan, group and children.

4.3.3 Evaluation of farmers' adaptation practices

Key criteria and their implications for adaptation to climate change are discussed below, including effectiveness and sustainability, and flexibility of the adaptation practices. In addition

to these, a classification of the adaptation practices into farm production practices and farm financial management practices is used to further evaluate farmers' climate change resilience given the portfolio of adaptation practices.

4.3.3.1 Effectiveness and sustainability of the adaptation practices

During the exploratory workshop farmers ranked the different adaptation practices with regard to effectiveness, based on assurance of food security by the adaptation measures amidst the climate vagaries. Adaptations including; early planting, enterprise mix (diversification), use of early maturing crops or varieties, use of drought or flood tolerant crops/varieties, growing of crops in swamps, shifting cultivation and tree planting were ranked highly by farmers (Table 25). However, in a study to appraise climate change response in Uganda, Hepworth and Goulden (2008) questioned the capacity of available adaptation practices to maintain resilience sustainably in the long term.

Table 25: Ranking of effectiveness of adaptation practices by farmers

Adaptation practices	Level of effectiveness (score*)	Reasons for score
Shifting cultivation	***	Risk reduction
Growing fast maturing crops to	**	Limited by access to planting material
Early harvesting	***	Avoids total loss
Diversion channels	*	Limited where flooding or logging is intense
Flood/drought/wind tolerant crops/varieties	***	Risk reduction
Growing crops in swamps	***	Risk reduction
Early maturing crops	***	Risk reduction
Irrigation	*	Limited access to irrigation technologies
Enterprise mix to reduce risk	***	Spread the risk
Tree planting (for strong winds)	***	Reduces destruction of crops

Source: Climate change workshop, September, 2010, Gweri sub county, Soroti

For instance, although shifting cultivation (upland or low land) was ranked as highly effective by farmers, it was categorized among practices that have negative environmental impact by the Uganda NAPA (2007). Both shifting cultivation and grazing are limited by increasing land pressure, in addition to the risk of irresponsible exploitation of resources they may encourage.

On the other hand, shifting cultivation to lowlands (encroachment on swamps) will most likely conflict with environmental protection laws. Also, though use of diversion channels was ranked as fairly effective, during extreme flooding they would be rendered useless, unless some further adjustments were made. Practices that farmers ranked as effective are not environmentally friendly or sustainable which raises the question of whether the effectiveness of a given practice will be sustained in the short/medium and long term given a range of possible climate scenarios in the future.

The adaptation practices were also differentiated into tactical and strategic practices. Tactical adaptations include adjustments made within a season that involve dealing with a particular climatic condition in the short term, while strategic adjustments may include structural changes in the farm operation or changes in enterprises or management that would apply for a subsequent season, or a longer term (Smit & Skinner, 2002). Categorizing the adaptation practices into the two groups indicates a balance between the tactical and strategic practices as well as across male and female headed households (Table 26). Given the long term impacts climate change could have on livelihoods, strategic adaptation practices are more desirable as they encourage greater anticipation and planning to foster current and future resilience of communities. Tactical adaptation practices should be used within a strategic framework of adaptation which considers a range of possible future climate scenarios, but not on their own.

Table 26: Categorization into tactical and strategic adaptations (n=89)

Tactical responses (40%)		Strategic responses (60%)	
Male HH (40%)	**Female HH (42%)**	**Male HH (60%)**	**Female HH (58%)**
▪ shifting cultivation/ shifting grazing area ▪ changing planting dates/early planting	▪ early harvesting ▪ simple irrigation/ watering animal ▪ fencing off animals in windy conditions	▪ off-farm employment ▪ tree planting ▪ crop diversification/ intercropping ▪ new crop or animal species/crop rotation ▪ use of improved pastures	▪ improved varieties/ breeds ▪ mixed farming ▪ vaccination ▪ mulching ▪ diversion channels

Total percentage for each category is a sum of the percentages of households using the practices under the respective category

4.3.3.2 Flexibility of the adaptation practices

The term flexibility of an adaptation practice is its ability to reduce vulnerability to risks of climate change and variability and function in light of a range of climate conditions (Dolan et al., 2001). Accordingly, more flexible adaptations would be more beneficial and cost effective and thus more preferred. As UNFCCC (2007) notes, the most effective adaptation approaches for developing countries are those capable of addressing a range of environmental stresses and factors.

Table 27: Use of the adaptations over the range of climate conditions (n=89)

	Drought (%)	Floods (%)	Strong winds/storms (%)	Overall (%)
Improved varieties	31	8	24	25
Timely planting	33	21	10	27
New crop species	12	22	10	13
Diversification	9	15	14	10
Up/lowland shifting cultivation	5	22	4	8
Tree planting	2	-	38	6
Irrigation	6	-	-	4
Mulching	1	-	-	1
Crop rotation	1	-	-	1
Early harvesting & storage	-	2	-	1
Water ways/diversion channels	-	10	-	4
	100%	100%	100%	100%

According to findings in Table 27, flexibility of the various adaptation practices does vary. For instance, improved varieties, timely planting, intercropping or diversification, and use of new crop varieties tended to be cross-cutting for the three climate conditions. These practices were also used by the majority of farmers (83%). However, some practices tended to be specific for a given climate condition, for instance, diversion channels and early harvesting/storage for floods, and mulching, crop rotation and irrigation for drought. Others were applicable to two climate situations. Therefore, in order to guarantee resilience in areas with multiple climate change events, promotion of cross-cutting adaptation practices should be emphasized.

4.3.3.3 Form of adaptation: Farm production practices versus farm financial management practices

According to Smit and Skinner (2002), form, which relates to the process through which adaptation in agriculture occurs, is an important aspect in distinguishing among adaptation

practices. Accordingly, adaptations can be differentiated by their administrative, financial, institutional, legal, managerial, organizational, political, practical, structural, and technological characteristics. As such, the different farm-level adaptation practices were classified into two main categories: farm production practices and farm financial management. Examples and distribution of the adaptation practices under the two categories are presented in Table 28.

Table 28: Farm-level production and financial management adaptation practices in Soroti (n=89)

1. FARM PRODUCTION PRACTICES(99.3 %)	**SPECIFIC EXAMPLES UNDER EACH CATEGORY**
Farm production	
• Diversify crop types and varieties, including crop substitution	▪ New crop species (9.3%), fast maturing (0.4%) ▪ Improved varieties (20.7%) ▪ Crop diversification (8.4%)/intercropping (0.9%) ▪ Mixed farming (0.9%) ▪ Tree planting (5.3%)
• Diversify livestock types and breeds	▪ Better adapted animal species (5.7%) ▪ Improved breeds (0.4%)
• Intensification of production - improvement in management practices to reduce stress on animal	▪ Animal restriction e.g. in windy conditions (0.4%) ▪ Use of improved pastures (1.3%) ▪ Watering animals (0.9%) ▪ Vaccination (1.3%)
Land Use	
• Change the location of crop and livestock production	▪ Shifting grazing area (4%)
• Use alternative soil/water conservation practices	▪ Diversion channels (0.4%) ▪ Mulching (0.4%) ▪ Crop rotation (0.4%)
Land topography	
• Change land topography	▪ Shifting cultivation from low to high topography in case of flooding (5.3%)
Irrigation	
• Implement irrigation practices or watering of animals	▪ Simple irrigation e.g. use of plastic bottles/bags (4.4%) ▪ Water harvesting (2.2%) and water resource management (0.4%)
Timing of operations	
• Change timing of farm	▪ Timely planting (25.5%) ▪ Early harvesting and storage (0.4%)
2. FARM FINANCIAL MANAGEMENT (0.7%)	
Household income	
• Diversify source of household income	▪ Off-farm employment (0.7%)

The findings in Table 28indicate that the bulk of adaptation practices (over 99%) fall under the category of farm production practices while farm financial management accounts for less than 1%. This highlights a lack of farm financial management practices such as those in more advanced economies, including crop insurance, investment in crop shares and futures and participation in income stabilization programs tailored to protect small-scale farmers (Smit& Skinner, 2002). Instead, farm-level adaptation is largely dependant on production practices which are climate sensitive and therefore cannot ensure adequate adaptive capacity for farmers.

As Thomas and Twyman (2004) posit, there is need for economic space and capacity for diversification beyond and within natural-resource. However, diversification may not necessarily make people resilient to climate impacts. This is because the majority of alternative livelihood activities are also dependent on natural resources either directly (cultivation, livestock, forestry, fisheries) or indirectly (trading and service activities) which are also heavily influenced by climate (Hepworth & Goulden, 2008). Since the ability to diversify livelihoods is also often limited by insufficient capital in households, Hepworth and Goulden (2008) posit that the strength of social bonds in a community can be an important element in climate change adaptation. The findings have key policy implications for strengthening climate change adaptation through promoting improved farm production practices, further development of the farm financial management profile and increasing rural income options (i.e. income diversification) of the local people.

4.4 Household Members' Contribution to Climate Change Adaptation

This section looks at how the adaptation ideas were introduced to the various adapting households and the distribution of roles and responsibilities of household members in the actual implementation of the ideas. The section proceeds with an assessment of household members' contribution to household farming and adaptation innovation, and concludes by differentiating between men's and women's roles in implementing climate change adaptations on the farm.

4.4.1 Household members' contribution to farming and adaptation innovation

Close to 77% of male headed households and 73% of female headed households reported to have made adjustments due to perceived climate changes. However, a sharp contrast is found when

comparing the contribution of household members in terms of introducing adaptation ideas in male headed households - 80% of the adjustments were attributed to husbands while only 15% of the adjustments were attributed to wives. Children and other family members contributed just 5% in introducing innovations with specific regard to adaptations to climate change.

However, data on whether women had introduced agricultural ideas in male headed households, in general, that is, without specific regard to adaptation, shows a rather different perspective. This is because in 60% of male headed households, women had introduced a new farming innovation and almost all the ideas (97%) had been implemented, with considerable support from husbands. The support included provision of labour, such as, helping with collection of water for irrigation (48%); buying inputs such as improved varieties and pesticides (26%), mutual consent (20%) and guaranteeing access to more land (6%) (n=40). Limited household labour was cited as a hindrance to husbands' support to wives. On the other hand, women's failure to introduce new farming ideas was attributed to limited exposure to learning opportunities (68%), low education levels and experience (16%), lack of interest (11%) and heavy domestic workloads (5%) (n=28). Thus, adaptation interventions need to deliberately find ways of harnessing women's potential to contribute more towards household adaptation.

4.4.2 Household members' roles in implementing climate change adaptation

Findings in Table 29 suggest that men's and women's roles and responsibilities in relation to climate change adaptation on the farm vary. Men were seen to be more involved with decision-making (32%) compared to 20% of women; and in selling of proceeds from the utilization of adaptation practices (28%) of men compared to 16% of women. Women on the other had were more involved with planting (47%), weeding (22%), and harvesting (24%), and compared to 16%, 13% and 11% of the men. In other words, men are dominant when it comes to selling proceeds from adaptation endeavors and are better positioned to make adaptation decisions in the household. Women on the other hand are more likely to undertake more intensive activities related to implementing climate change adaptation.

Table 29: Gender roles in adaptation related farm actions

Adaptation farm actions	Husbands		Wives		Total	
	Count	**%**	**Count**	**%**	**Count**	**%**
Decision making	49	32.2	21	19.6	70	27.0
Planting	24	15.8	21	46.7	45	17.4
Weeding	19	12.5	24	22.4	43	16.6
Harvesting	17	11.2	24	24.4	41	15.8
Selling	43	28.3	17	15.9	60	23.2
Total	152	100	107	100	259	100

This distribution of activities is similar to gendered distribution of agricultural roles and responsibilities in agriculture in Uganda and Africa at large. For instance IAASTD (2009) notes that it is women and girls who normally perform tasks such as planting, transplanting, hand weeding, harvesting, picking fruit and vegetables, small livestock rearing, and postharvest operations such as threshing, seed selection, and storage on the other hand, mechanized work (preparing the land, irrigation, mechanical harvesting, and marketing) is generally a male task. In addition, women and girls are expected to carry out other domestic roles, including housekeeping, child rearing and fetching water and fuelwood. Thus, their manual and time burden tends to increase relative to men and boys. Excessive workload of women from subsistence and reproductive work implies that women devote much less time than men on income generating activities and thus are most likely to get lower incomes (Koopman, 1997).

Furthermore, having less control over benefits from climate change adaptation endeavors may further reduce women's keenness in adopting and implementing adaptation practices. This is especially important where husbands and wives may have different priorities or interests. For instance, in a case study in South Africa, Babugura (2010) found that social grant money provided to help households to cope with climate change stress was spent by men on buying alcohol instead of household needs. Therefore, since women have been identified as important players in agriculture and specifically in climate change adaption in agriculture, their involvement in adaptation relate decision-making and control of proceeds from adaptation efforts should be nurtured. In this regard, deliberate steps must be undertaken to confront the existing socio-cultural patterns responsible for the perceived differences between men and women. For instance, Angula (2010) in a case study in Namibia pointed to the need to counter bad attitudes from local leaders who did not seem to understand that gender considerations were necessary in addressing the climate change issue sufficiently.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

Perceptions and knowledge play a key role in shaping individual and collective response to climate change. Furthermore, understanding what types and forms of adaptation are possible, feasible and likely; and who would be involved in their implementation is an important step towards facilitating effective climate change adaptation. Also, a successful campaign takes into consideration equitability which calls for extensively examining the gender aspects of adaptation to climate change. This study focused on three objectives; 1) evaluating male and female farmers' climate change perceptions and knowledge; 2) characterizing and evaluating male and female farmers' climate change adaptation practices; and 3) assessing household members' contribution to household climate change adaptation.

5.1 Evaluation of Male and Female Farmers' Climate Change Perceptions and Knowledge

The majority of male and female farmers were aware of climate change, but perceptions on specific changes such as decrease in rainfall may not always agree with analyses based on scientific data. Also, it is apparent from the study that women, being more closely concerned with household welfare are more stressed by droughts and thus more likely to perceive their increased occurrence. Concerning the future, there is relatively high optimism that things could get better if only the disincentives that frustrate people's efforts and hopes are institutionally mitigated. The study recommends that climate change adaptation interventions should engage both men and women so as to get a holistic understanding of community perceptions, while also ensuring harmonization of local knowledge and perceptions with scientific thinking, in addition to mitigating disincentives to positive behavioral change. Adaptation campaigns by government (MWLE) under the NAPA, and other concerned agencies and organizations e.g. GEF, NFA, UNEP, NGOs and other partners involved in promoting effective adaptation to climate change should capitalize on the high perception levels that have been observed so as to stimulate appropriate/desired responses. This can be done by disseminating appropriate information on climate trends, in addition to appropriate actions in a timely manner to both male and female farmers.

5.2 Determinants of Knowledge of Climate Change among Male and Female Farmers

Women were less knowledgeable about climate change, gender being the sole determinant of climate change knowledge. This may be attributed to the lower levels of education and access to sources of information, namely, radio, extension and groups amongst women as compared to their male counterparts which undermine their capacity for climate change adaptation. The study recommends that government climate change adaptation policy should emphasize the need to close gaps in access to information sources such as radio, agricultural extension and farmer organizations as well as education in general through appropriate policy and sensitization of men and women. Agencies and organizations concerned with climate change adaptation should regularly provide localized, up-to-date, quality information on climate change to both men and women in forms that can be easily understood. This is especially important for women since more knowledge on climate change actually increases the likelihood of taking appropriate action.

5.3 Characterization and Evaluation of Male and Female Farmers' Adaptation Practices

The proportion of households adapting to climate change compared to the proportions of farmers who perceived climate changes was high across male and female households. Uptake of the practices was mostly influenced by fellow farmers and extension works. Adaptation was mainly linked to drought in both livestock and crop enterprises, but was generally more prevalent in the crop enterprises. A similar adaptation pattern was revealed across male and female households. This is probably because the female heads take after male heads and thus carry out similar practices, unless otherwise picked up afterwards. Although the majority of farmers employed flexible adaptation practices across the climate change events, they do not necessarily consider their sustainability and range of future climate change scenarios. Also, the resilience of male and female farmers is not guaranteed given that the bulk of their adaptation practices are climate change dependant. The study therefore recommends that the NAPA and other agencies concerned with climate change adaptation integrate the following in their strategies: adaptation to climate change should be strengthened through promoting improved farm production practices, while also emphasizing further development of the farm financial management profile and increasing rural income options within and beyond agriculture should be emphasized; developing an effective adaptation program should build the capacity of farmers to adapt to all the common climate change stresses for all important enterprises in the area. This requires

building local capacities for developing and multiplying appropriate and affordable adaptation technologies and innovations, improved access to and quality of climate information, promotion of rural entrepreneurship and general improvement of rural infrastructure to provide a favorable environment for diversification of economic activities.

5.4 Assessment of Male and Female Farmers' Contribution to Household Climate Change Adaptation

The assessment of men's and women's contribution towards introduction of climate change adaptation practices revealed that women's contribution was much lower compared to that of men. However, their potential as reflected by their contribution in introducing farming innovations to the household in general shows that women can do more in contribution towards adaptation. Furthermore, women shoulder the more labor intensive adaptation related activities that is, planting, weeding and harvesting, while men are more involved with decision making and sell of the proceeds. Whereas women supply most of the labor for adaptation on the farm, their limited power to make adaptation decisions and reap from proceeds thereof poses a hindrance to the success of adaptation interventions. The study thus recommends that the all NAPA interventions are deliberate on harnessing women's potential by doing the following: increasing women's exposure to learning and training opportunities, boosting their participation and finding ways of easing their work burdens to increase their time for such engagements. Generally, interventions should be fashioned to leverage equal opportunities for both men and women to enable meaningful and genuine participation and benefits for both men and women.

5.4.1 Suggestions for Further Research

The following areas are suggested for further research:

1. The determinants of male and female farmers' preference for climate change adaptation practices
2. Measurement of climatic and non-climatic influences on climate change adaptation.
3. The roles played by women and men in climate change adaptation beyond the household and how they are facilitated to effectively and efficiently carry them out amidst gendered expectations

4. The role of local institutions and organizations in reinforcing climate change adaptation.

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APPENDICES

Appendix 1: Interview schedule

A. Survey identification information		
A.1	Date	
A.1	Household code	
A.2	Name or initials of enumerator	
A.3	Name of district	
A.4	Name of Sub county	
A.5	Name of village (LCI)	
A.6	Date of interview	
A.7	GPS coordinates	Northings: Eastings:
A.8	Elevation	
B. Household characteristics: Respondents should preferably be the head of household (male or female) and/or the/a wife, but could also be any other adult members of the household		
B.1	Name of respondent	
B.2	Sex of respondent	1. Male 2. Female
B.3	Age of Respondent	____Years
B.4	Name of household head	
B.5	Sex of household head	1. Male 2. Female
B.6	Age of household head (if not respondent)	
B.7	Education level (Such as P.7,S.3,S.6;*to be computed into years of schooling)*	a. Household head ..... b. Spouse.....
B.11	How long has this household been engaged in farming?	Number of years…….

<table>
<tr>
<td>B.12</td>
<td>a). What is the size of yourland in ha?
b). Who owns the land? Please specify the unit of measurement e.g. acres or miggo and convert all units to ha.

<u>Ownership codes:</u>
1. Household head,
2. spouse,
3. both man and wife
4. clan family
5. hired(indicate amount of hired land)</td>
<td>
<table>
<tr><td>Plot</td><td>Size(ha)</td><td>ownership</td></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td></td></tr>
</table>
</td>
</tr>
<tr>
<td>B.13</td>
<td>a). Which other assets does your household have?
b). How many of each?
c). Who owns the assets?
d). How are the assets used by household members?

<u>*Ownership codes</u>:
1. Owned by husband
2. Owned by spouse
3. Owned as a group
4. Joint ownership between husband and wife
5. Owned by children
6. Other, specify.....

<u>** Usage codes</u>
1. Used by husband only
2. Used by wife only
3. Used by husband and wife alone
4. Used by children only
5. Used by all household members</td>
<td>
<table>
<tr><td>Item</td><td>Number</td><td>*Ownership Status</td><td>**Usage</td></tr>
<tr><td>a. Ox ploughs</td><td></td><td></td><td></td></tr>
<tr><td>b. Hoes</td><td></td><td></td><td></td></tr>
<tr><td>c. Panga</td><td></td><td></td><td></td></tr>
<tr><td>d. Radio</td><td></td><td></td><td></td></tr>
<tr><td>e. Phone</td><td></td><td></td><td></td></tr>
<tr><td>f. Tractor</td><td></td><td></td><td></td></tr>
<tr><td>g. Motorcycle</td><td></td><td></td><td></td></tr>
<tr><td>h. Bicycle</td><td></td><td></td><td></td></tr>
<tr><td>i. Car</td><td></td><td></td><td></td></tr>
<tr><td>j. Spray pump</td><td></td><td></td><td></td></tr>
<tr><td>k. Others, specify</td><td></td><td></td><td></td></tr>
</table>
</td>
</tr>
</table>

	ii). If **NO**, please state why you did not use any purchased inputs	
	iii). Can youremember anyinstancewhenyourwife identified a new technology in farming? ***(formen)***	Yes=1 No =0 /_____/ Givereasonsfor YES or NO…… …… …… …….
	iv). If**YES**to (iii) above, specify: a). What idea itwas b). wassheabletoimplementthe new idea? c). Whatsupportdidthehusbandgivetothewife? .	<table><tr><th>***Idea identifiedbywife***</th><th>***Abletoimplement (YES/NO)***</th><th>***Supportgivenby husband***</th></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table>
B.17	i). Do you belong to any farmer group /farmer organisation/association?	Yes=1 No =0 /_____/. If yes, please specify name(s) ……. ……. …….
	ii). If **YES**, please specify: a). Name the organisations to which you are a member b). The purposes of the organisations	a). Name of organizations……. b). Purposes of organizations…… ….. …… ……. …… …….. …… ……..
B.18	i). Do you have access to extension services	Yes=1 No =0 /_____/
	ii). If **NO,** please specify why you have no access	

	iii). If **YES**, Specify: a). Service provider b). Major area of focus c). Number of contacts in last 6 months	<table><tr><th>Service provider</th><th>Major area of focus</th><th>Frequency of contacts in last 6 months</th></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table>
B.20	i). Did you have access to credit forfarming from any sources in the last year?	Yes=1 No =0 /_____/
	v). Whatchallenges do youface in accessingcredit?	
C. Climatechangeawareness and knowledge		
C .2	i). <u>Please circle the option that most represents your views on the following statements using the scale provided:</u> a). Long-term changes in climate over the last 15 years have been noticed in the village	**<u>Scale</u>** 1. StronglyAgree, 2. SomewhatAgree 3. SomewhatDisagree 4. StronglyDisagree 5. Don'tKnow
	b). Over the last 15 years, days have been getting hotter	**<u>Scale</u>** 1. StronglyAgree, 2. SomewhatAgree 3. SomewhatDisagree 4. StronglyDisagree 5. Don'tKnow
	c). Over the last 15 years, days have been getting colder	**<u>Scale</u>** 1. StronglyAgree, 2. SomewhatAgree 3. SomewhatDisagree 4. StronglyDisagree 5. Don'tKnow
	d). Rainfall has been decreasing over the last 15 years	**<u>Scale</u>** 1. StronglyAgree, 2. SomewhatAgree 3. SomewhatDisagree 4. StronglyDisagree 5. Don'tKnow

<table>
<tr><td></td><td>e). Length of wet and dry seasons has changed</td><td><u>Scale</u>
1. StronglyAgree,
2. SomewhatAgree
3. SomewhatDisagree
4. StronglyDisagree
5. Don’tKnow</td></tr>
<tr><td></td><td>f). 1). Floods are becoming more frequent
2). Floods are becoming more intense
3). Droughts are becoming more frequent.
4). Droughts are becoming more intense
5). Strong winds are becoming more frequent.
6). Strong winds are becoming more intense</td><td><table><tr><td></td><td>Becoming more frequent</td><td>Becoming more intense</td></tr><tr><td>Floods</td><td></td><td></td></tr><tr><td>Droughts</td><td></td><td></td></tr><tr><td>Strong winds</td><td></td><td></td></tr></table>
<u>Scale</u>
1. StronglyAgree 2. SomewhatAgree 3. SomewhatDisagree4. StronglyDisagree5. Don’tKnow</td></tr>
<tr><td></td><td>ii). State years in which the climatic events were experienced in the last 15 years</td><td><table><tr><td>Climate Events</td><td>Years of occurrence</td></tr><tr><td>Floods</td><td></td></tr><tr><td>Droughts</td><td></td></tr><tr><td>Storms</td><td></td></tr></table></td></tr>
<tr><td></td><td>iii). For changes in rainfall received, please specify the average length in months of dry and wet seasons now and before changes</td><td><table><tr><td></td><td>Before changes</td><td>Now (current)</td></tr><tr><td>Dry season</td><td></td><td></td></tr><tr><td>Wet season</td><td></td><td></td></tr></table></td></tr>
</table>

<table>
<tr><td>C
.3</td><td>i). According to you, what is causing these changes in the climate? (Specify for each)
a). Floods
b). Droughts
c). Strong winds

ii). Please explain your response (probe)</td><td>
<table>
<tr><th>Change</th><th>Cause</th><th>Explanation for cause</th></tr>
<tr><td>Floods</td><td></td><td></td></tr>
<tr><td>Droughts</td><td></td><td></td></tr>
<tr><td>Storms</td><td></td><td></td></tr>
</table>
*Cause codes:
1. Cutting of trees
2. Poor farming practices
3. Bush burning
4. Supernatural forces
5. Don’t know
6. Others, specify …….
</td></tr>
<tr><td colspan="3">D. Climate change adaptation</td></tr>
<tr><td>D.1</td><td>i). Have you made any adjustments to your farming practices to cope with these weather/climate changes?</td><td>Yes=1 No =0 /_____/.</td></tr>
<tr><td></td><td>ii). If NOT, why haven’t you made any adjustments to climate change?</td><td>1. Lack of money
2. Lack of credit
3. limited land
4. lack of new planting materials
5. lack of equipment
6. lack of knowledge on adaptation options
7. it wouldn’t make a difference
8. Shortage of labor
9. Not affected by climate changes
10. Not aware of climate changes
11. Others (specify)……</td></tr>
</table>

iii). If **YES**, please specify:

a). Thekey adjustments in **crop farming** to cope with each change (drought, floods & strong winds/storms)
b). Reasons for choosing a particular adjustment
c). Source of knowledge/skills/technologies used to cope with the changes
d). The year when implementation of adaptation was done

Drought

Key adjustments	***Crop***	***Reason***	***Source of info***	***When implementation was effected (year)***
1.				
2.				
3.				
4.				

Floods

Key adjustments	***Crop***	***Reason***	***Source of info***	***When implementation was effected (year)***
1.				
2.				
3.				
4.				

Strong winds and storms

Key adjustments	***Crop***	***Reason***	***Source of info***	***When implementation was effected (year)***
1.				
2.				
3.				
4.				

Adaptation codes: 1= Early planting 2= using improved varieties;3=changing planting dates; 4= use of new crop species that are
better adapted; 5= irrigation; 6= crop diversification; 7=intercropping; 8= shifting cultivated land; 9= water harvesting; 10= tree planting; 11= change to off farm employment 12=other(specify)

*Source codes: 1=Extension officers 2=TV 3=Radio 4=Fellow farmers 5=Others, specify ……..

Reason Codes: 1= Higher yield, 2= Drought tolerance, 3= Early maturity; 4=Adapted to soil conditions; 5= Adapted to higher temperatures; 6= suitable for flooded conditions 7= other,specify……..

iv). If **YES**, please specify:

a). Thekey adjustments in **livestock farming** to cope with each change (drought, floods & strong winds/storms)
b). Reasons for choosing a particular adjustment
c). Source of knowledge/skills/technologies used to cope with the changes
d). The year when implementation of adaptation was done

Drought

Key adjustments	***Type of livestock***	***Reason***	***Source of info***	***When implementation was effected (year)***
1.				
2.				
3.				
4.				

Floods

Key adjustments	***Type of livestock***	***Reason***	***Source of info***	***When implementation was effected (year)***
1.				
2.				
3.				
4.				

Strong winds and storms

Key adjustments	***Type of livestock***	***Reason***	***Source of info***	***When implementation was effected (year)***
1.				
2.				
3.				
4.				

Adaptation codes: 1= use of livestock species that are better adapted; 2= use of mixed crop and livestock systems; 3= water
harvesting;4= management of water resources; 5= use of improved pastures ; 6= changing grazing area,7= Destocking, 8= change animal breeds;9=other

*Source codes: 1. Extension officers 2. TV 3. Radio 4. Fellow farmers 5. Others, specify

Reasons: 1= Higher fertility, 2= Drought tolerance,; 3= Adapted to higher temperatures; 4= shortage of feed;
8= to supplement feed, 9= shortage of grazing land 10=others,specify

D.2	i). a). Who in the household got each of the new practices first hand? b).who in your household is using it now?	<table><tr><th>*Adaptation*</th><th>**Household member who got it first*</th><th>***Household member using it now*</th></tr><tr><td>1.</td><td></td><td></td></tr><tr><td>2.</td><td></td><td></td></tr><tr><td>3.</td><td></td><td></td></tr><tr><td>4.</td><td></td><td></td></tr><tr><td>5.</td><td></td><td></td></tr><tr><td>6.</td><td></td><td></td></tr><tr><td>7.</td><td></td><td></td></tr><tr><td>8.</td><td></td><td></td></tr><tr><td>9.</td><td></td><td></td></tr></table> ***Household member who got idea first codes:** 1. Household head 2. Spouse 3. Children 3. Other, specify…… …… ****Household member using idea now codes:** 1. Household head 2. Spouse 3. Both 4. Children
D5	How was labour divided during implementation of the strategies?	<table><tr><th>*Adaptation Activities*</th><th>*Man*</th><th>*Spouse/woman*</th><th>*children*</th></tr><tr><td>1.</td><td></td><td></td><td></td></tr><tr><td>2.</td><td></td><td></td><td></td></tr><tr><td>3.</td><td></td><td></td><td></td></tr><tr><td>4.</td><td></td><td></td><td></td></tr></table> Activity codes: 1. decision to implement 2. Planting 3. Clearing land 4. Weeding 5=Harvesting 6= Selling 7= Others, specify …… Weeding 5=Harvesting 6= Selling 7= Others, specify ……
E. Policy interventions to enhance climate change adaptation		
F. 1	What do you think the future of climate change is likely to be?	**Codes:** 1.Worse 2. Better 3. Don't know 4. Can improve if something is done
F. 2	i). Do you think something can be done to change the situation in future?	Yes=1 No =0 /_____/.
	ii). If **NO**, please explain why not	**Reason codes**: 1.The end of the world has come, 2.Lack of goodwill from the people, 3.Limited livelihood options, 4.Corruption, 5.Others,..... ....

iii). If **YES**, please specify what can be done and by who

Level	*Actions*	*By who*	*Likely challenges in implementing actions*
Household level			
Community level.			
Government level			

Appendix 2: Interview schedule review expert panel

Name	**Qualification**
1. Margaret N. Mangheni	Associate Professor, Department of Extension and Innovation Studies
2. HaroonSseguya	Lecturer, Department of Extension and Innovation studies
3. J. G. M. Majaliwa	Associate Professor, Department of Natural Resources and Environment
4. Bernard Bashaasha	Associate Professor, Department of Agricultural Economics and Agribusiness School

Appendix 3: Tests of multicollinearity between independent variables for regression of knowledge of climate change causes

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.345[a]	.119	.084	.62432

a. Predictors: (Constant), age of the household head, if the household received extension services, if the household accessed credit for farming from any sources , sex of the household head

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.270	4	1.317	3.380	.012[a]
	Residual	38.978	100	.390		
	Total	44.248	104			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
1		B	Beta	Beta	t	Sig.	Tolerance	VIF
	(Constant)	2.930	.236		12.407	.000		
	sex of the household head	-.480	.133	-.346	-3.599	.000	.954	1.048
	Access to extension	-.068	.125	-.052	-.541	.590	.967	1.034

	services							
	Accessed to credit	-.069	.129	-.051	-.533	.595	.967	1.035
	Age of the household head	-.002	.005	-.033	-.351	.727	.985	1.015

a. Dependent Variable: knowledge of cause of climate change