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EVALUATING THE UTILISATION OF CLIMATE-SMART AGRICULTURAL TECHNOLOGIES BY SMALLHOLDER FARMERS: A CASE IN KYENJOJO DISTRICT, UGANDA

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ABSTRACT

Climate change is already affecting the agriculture sector in Uganda, characterised by prolonged droughts, unpredictable and erratic rainfall that result in crop failure and lower yields for the farmers. This study evaluates the utilisation of climate-smart agricultural technologies by smallholder farmers in Nyantungo Subcounty, Kyenjojo District. The study was based on three specific objectives: to identify climate-smart agriculture technologies being implemented, to examine the benefits based on the farmers' experience, and to assess the challenges of adopting to climate-smart agriculture technologies. Qualitative information was collected with 25 semi-structured interviews with 11 female and 14 male respondents. Data was analysed using thematic content analysis. From the findings, it appears that the climate-smart agriculture technologies practiced were: soil and water conservation (rainwater harvesting, irrigation, mulching, cover cropping), energy on-farm conservation (minimum tillage, efficient saving stoves), scientific and indigenous knowledge technologies (early planting, planting of improved seed varieties tolerant to drought or rain), nutrient management (intercropping with legumes, use of animal waste or manure) and carbon management (cultivation/intercropping with leguminous plants, agroforestry, fruit trees, fodder crops). The benefits of the technologies included increased yields, and environment and micro-climate modification. However, farmers faced challenges in implementing these technologies, including a lack of financial resources for investment, the technologies are labour intensive, inadequate extension services, and limited access to markets. In terms of gender involvement, it was found that there were differences between how women and men headed households adopt and implement different technologies. Based on the study outcomes it is recommended that the government plans for provision of water for production to make irrigation possible throughout the year, negotiate with banks for provision of affordable credit facilities, strengthening of the agricultural extension services, and that farmers organize themselves into groups for proper collaborations.

Key words: climate change, climate-smart agriculture technologies, adoption challenges, Kyenjojo Uganda

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1. INTRODUCTION

1.1 Background

The agriculture sector plays a key role in the national socio-economic development of the different countries in Africa and for smallholder farmers who derive their income, food and nutritional security from it (Menike & Arachchi 2016). The sector employs about 60% of the population in Africa of which about 60-80% are women (Palacios-Lopez et al. 2017). In Uganda the sector employs about 72% of the labour force of which 77% are women and 64% are the youth who live in the rural areas (GoU [Government of Uganda] 2015). In the 2013/2014 financial year, agriculture contributed to roughly 25% of the National GDP and a total export earnings of up to 40% in the 2012/2013 financial year for Uganda (GoU 2015).

Smallholder farmers in Uganda face numerous risks to their agricultural production not only because of climate change, including pest and disease outbreaks and extreme weather events, but also because of market shocks. Together they often undermine the households' food supply, its nutritional demands, as well as its income security. Kyenjojo District has 24 administrative units including Nyantungo Subcounty and is among the districts that are affected by extreme weather and climatic stress, including low precipitation and unpredictable rainfall patterns, prolonged droughts and heat waves (World Bank 2009). It is this same district that forms the focus area of this study.

If we zoom in more closely at Nyantungo Subcounty and Kyenjojo District, we see that the area not only faces climate change problems, but also has to deal with other problems such as disease, inadequate health care as people need to walk more than 8 kms to access government health centre services, an illiteracy rate of 33%, an 11% poverty rate, a high dropout rate from school, lack of clean water in the different parishes, and poor road connectivity, especially during the rainy seasons (UBOS [Uganda Bureau of Statistics] 2014; Kyenjojo District 2019). As the agriculture sector is predominantly rain-fed, it makes the sector highly vulnerable to climatic stress and in cases of natural calamities it can result in losses, very low yields and subsequently hunger and poverty (World Bank 2009). Nyantungo Subcounty is well known for producing maize (corn), Irish potatoes, beans, cassava, groundnuts and millet for both home consumption and sale. Some farmers in the subcounty also have coffee and tea plantations and some farmers equally rear animals, including cattle, goats, sheep, pigs and chickens. Drought and rainfall affect the growth of pastures for animal feed. Hence, continued low productivity is affecting farmers' capacity negatively and makes it a challenge to provide for their families both enough food and income to solve the other family problems such as health needs, education and other necessities.

The impact of climate change is creating a growing interest in sustainable agricultural management practices to reduce land degradation and promote climate change resilience and reduce greenhouse gas emissions (Beuchelt & Badstue 2013). However, due to climate change effects on agriculture, there is more likely a risk of decreased food supplies, causing hunger and poverty in the long run (Niang et al. 2014). Food shortage could affect the world's fight to achieve the United Nations Sustainable Goals 1 and 2 (UN 2015). Thus, it is pertinent to study and identify climate-smart agricultural technologies in the Nyantungo Subcounty in order to see how these technologies could be used to further mitigate the impact of climate change in the agricultural sector.

1.2 Study objectives

The main objective of this study was to evaluate the extent to which the farmers of Nyantungo Subcounty are aware of and utilize climate-smart agricultural technologies. The study further aimed to shed light upon the challenges that smallholder farmers face for adopting and utilizing such technologies. Moreover, by keeping a gender perspective in mind, differences between male and female smallholders are highlighted in this study. Finally, based on these study targets, recommendations for further improvement are provided.

1.2.1 Specific research objectives

i. To identify the climate-smart technologies being implemented by smallholder farmers in Nyantungo Subcounty, Kyenjojo District.
ii. To examine the benefits of climate-smart technologies for the smallholder farmers based on their experience.
iii. To assess the challenges of adopting climate-smart technologies in Kyenjojo District.

1.3 Research questions

i. What climate-smart technologies are being implemented by smallholder farmers?
ii. How effective are the climate-smart agricultural technologies according to the smallholder farmers?
iii. What are the challenges affecting adoption of climate-smart agricultural technologies in Kyenjojo District?
iv. Are households headed by both men and women implementing climate-smart agricultural technologies?

2. LITERATURE REVIEW

2.1 Climate change

The United Nations Framework Convention on Climate Change (UNFCCC 2014) refers to climate change as “a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and is in addition to natural climate variability observed over comparable time periods” (p.7). Climate change is yet another serious problem facing Africa in addition to hunger and diseases, resulting in unpredictable seasons characterized by prolonged droughts with high temperatures, more frequent high precipitation events, and occurrence of floods in many areas resulting in loss of property and life (FAO 2013). Ecosystem functions in the world are likely to be adversely affected by changes in climate, thus affecting the livelihoods of the larger population (MoFA-N [Ministry of Foreign Affairs, Netherlands] 2018). According to a study by the Ministry of Foreign Affairs of the Netherlands (2018), by the year 2045 Uganda is projected to receive high precipitation in the December to February season, which is now predominantly a dry season, meaning a change of seasons. However, rainfall patterns are expected to be unpredictable, resulting in less favourable rainfall distribution over the year and a projected precipitation range of -2% to +22% rainfall (MoFA-N 2018). Flooding and severe droughts have already started being experienced and are expected to continue in the different parts of Uganda, causing loss of life and destruction of property. Nyantungo Subcounty and Kyenjojo District are no exception and have also experienced long droughts and unpredicted seasonal changes that have resulted in low crop yields, loss of animal life and destruction of property (Orindi & Eriksen 2005; Mubiru et al. 2018)

2.2 Why climate smart agriculture (CSA)?

The Food and Agriculture Organisation (FAO) (2010) defines climate-smart agriculture (CSA) as "agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (greenhouse gases) (mitigation), and enhances the achievement of national food security and development" (page ii). However, Sullivan et al. (2013) also asserted that CSA "is sustainable agriculture, based upon integrated management of water, land and ecosystems at landscape scale" (p.1) that sustainably increases production and ecosystem resilience while reducing emissions of greenhouse gases. The onset of climate change makes it a challenge to maintain a healthy natural resource base as it constrains the ability of the populations to produce food sustainably. According to MoFA-N (2018), the soils in Uganda are exhausted, nutrient depleted and most importantly the variations in rainfall patterns are affecting 70% of the population dependent on agriculture. Equally the soils in Nyantungo Subcounty and Kyenjojo District have been cultivated over a long time, thus depleting soil nutrients, and are affected by soil erosion which makes crop production difficult on the different farms. The absence of conventional irrigation systems is another challenge; only 1% of the potential irrigatable agricultural land in Uganda is under irrigation. That is, only 15,000 ha out of 3,030,000 ha are under irrigation (GoU 2015).

CSA promotes the use of appropriate available technologies and practices that are aimed at promoting sustainable production in the agriculture sector. The technologies are targeted towards increased production for both food and income security, but also for mitigating the causes and impacts of the changing climate (FAO 2010). Uptake of CSA technologies is also seen as an opportunity towards reducing greenhouse gas emissions and offsetting the effects of climate change and variability on the agriculture sector (Khatri-Chhetri et al. 2017).

2.3 Implementation and impacts of climate-smart agricultural technologies

The introduction of new technologies in agriculture all over the world has been the order of the day in recent years, and technologies have improved on the prevailing conditions under which crops are grown. Of recent technology improvements can be mentioned the changing from one type of tools to another; from hand tools to machines. Future agricultural production will be enhanced with more sophisticated technology that will include shorter maturity periods of plants coupled with increased resistance to environmental factors to increase yields (Olmstead & Rhode 2011). Uganda has, however, been partly excluded from many of these technology changes because most people cannot afford to, for example, acquire machines such as tractors.

The implementation of climate-smart agricultural technologies individually or as a set of interventions has the potential to reduce climate change impacts on agriculture (Khatri-Chhetri et al. 2017). Adoption of CSA technologies and practices is influenced by the benefits of putting to use a specific technology. Among the factors that determine adoption are technology practicability, adoption barriers, and motivation mechanisms applied by government and other agencies that are providing technology support to the farmers and farming communities (Andersson & D'Souza 2014). However, the most effective way to encourage adaptation and mitigation of climate change is to integrate the objectives of agriculture and sustainable development, such as reduction of carbon emissions through reforestation and reducing industrial emissions, into strategies for poverty reduction and sustainable development. But it should be noted that adaptation is the immediate strategy before mitigation measures can have any impact. It is also of great importance to ensure that these approaches are owned and driven by the farmers themselves. The precise approaches to adapt to changing climate conditions will certainly be the right approaches for poverty reduction and sustainable development if appropriately implemented. In an attempt to adapt to climate change the following needs to be highlighted: addressing current challenges for strategic and tactical decision making, strengthening sustainable management of natural resources, strengthening early warning systems, risk recovery options, and strengthening capacity to make better assessments using new science tools (Rao 2013).

The climate change impacts on agriculture naturally suggest the need for technological innovations that the farmers can put to use in order to sustain production as climate change impacts strike. Among these technology innovations are those that sustain production under conditions of extreme heat and drought. Technologies that facilitate early planting of crops by farmers on the onset of the season could influence productivity such that crops are cultivated in time to utilise the early rains (Kucharik 2008). These technologies go a long way to help the smallholder farmers to act in time and crops to receive an appropriate amount of rain.

2.4 Farmers' perceptions and adoption behaviours

Farmers' awareness of the changing erratic rainfall patterns, differences in distribution in space and time, the decreasing amount of rain coming in the seasons and the delays, as well as the hot days and hotter nights in the different parts, which are signs of changing climatic conditions and extreme weather (Sahu & Mishra 2013), indicate that farmers understand that climate change is real.

The adaptation capabilities of farmers are influenced by their level of education, age, experience and income. Hence, farmers who score high on each of these characteristics will easily adapt to CSA technologies (Bagamba et al. 2012). A study by Zamasiya et al. (2017) in Zimbabwe reveals that access to agricultural extension services has an impact on the adoption behaviour of the farmers. Furthermore, access to agricultural extension services has a positive role in the adoption behaviour. Farmers in regular contact with the extension workers have up to date information on climate and weather, the availability of the different technologies in the area, and most importantly, the market options which may also drive adoption.

2.5 Gender and climate change

Gender is a key aspect of the agriculture sector since both men and women provide labour and derive their livelihood from the sector. In Africa, 50% of women are employed in the sector as farmers or labourers, and account for about 70-80% of the households' food provision in African communities (Sullivan et al. 2013). However, despite great involvement in the sector, women still find challenges regarding landownership, access to financial resources and access to markets which affect their productivity in the sector (Demetriades & Esplen 2008; FAO 2011; Sullivan et al. 2013) Reducing the gender inequality gap between women and men by creating opportunities for women to access production resources such as land, capital, markets and services could go a long way to significantly increase production, hence reducing poverty and hunger and thus fostering economic development the world. (FAO 2011; Beuchelt & Badstue 2013). FAO (2011) noted that if there was an increase in access to resources such as land, market, credit services, labour and technology for women to the same level as men have, it would generate increased production by 20-30% and eventually increase agricultural output by 2.5% to 4% in developing countries, resulting in a 12% to 17% decrease in world hunger.

Hence, during the conceptualization, proposal formation and implementation of CSA programs proper steps must be put into place to address gender issues. The way men and women respectively allocate their time or labour depends on the type of crops grown. For instance, men are more likely to allocate their labour to cash crops such as coffee, cotton, agroforestry and grazing of animals, unlike women who devote more of their labour and time to growing and production of food crops such as beans, Irish potatoes, sweet potatoes and vegetables (Palacios-Lopez et al. 2017). Furthermore, the literature shows that one of the economic factors that would affect women's labour allocation in agriculture are education levels where more educated women will allocate more time to labour and investments in crop production. The same is true when the land is owned by the women (Palacios-Lopez et al. 2017).

According to the literature, climate change impacts will not be uniform across the board, and discussions have come up that suggest that climate change effects are not gender neutral. Women in developing countries in Africa and Asia are said to be disproportionately affected by the changing climate (Demetriades & Esplen 2008; UNCSW [United Nations Commission on the Status of Women] 2008). This is because women are placed at the centre of the environment as natural resource users and caretakers, for example, fetching water, collecting fuelwood and other forestry products, depending on the wetlands etc. Thus, the occurrence of climate change effects, such as prolonged droughts, are more gendered, affecting women more than men. Hence linking gender to climate change is important for designing effective policies that are gender responsive (Nelson et al. 2002)

3. STUDY AREA AND METHODOLOGY

3.1 Description of the study area

Nyantungo Subcounty is one of the 24 administrative units of Kyenjojo District with about 205.5 sq.km. The area has an estimated population of 24,000 people (UBOS [Uganda Bureau of Statistics] 2014; Kyenjojo District 2019). The subcounty has five parishes of which Kyamutasa parish was the setting for this research. The area is settled by Batooro and a few migrant Bakiga who live together harmoniously. Rutooro is the language of communication understood by everyone in the area.

3.2 Research design

This study adopted a qualitative research design with 25 semi-structured interviews with both closed and open-ended questions. In the study, I examined the perspectives and knowledge regarding climate-smart agricultural technologies, adaptation strategies and challenges to adoption by smallholder farmers in Nyantungo Subcounty, Kyenjojo District.

3.2.1 Data collection

The data collection consisted of interviews with 11 women and 14 men which lasted between 45 and 60 minutes. Purposive sampling (Haines 2017) was used to select interviewees/respondents who are active in agriculture, both women and men, and who could provide the required information. The interviews were conducted at the selected farmers' homes and participants were asked to find a good place where they were not to be interrupted during the interview. The interviewees were informed that the research was about understanding their knowledge regarding the use of climate-smart agricultural technologies, benefits and challenges of adoption by smallholder farmers based on their experience in the wake of climate change. It was also mentioned to the interviewees that the researcher would keep the interviewees' identities anonymous, and that all the information provided would be treated as strictly confidential and was for the purpose of this research only. The interviewees had the right to opt out of the research at any time during the interview; however, none of them opted out. The interviewees were asked permission to have the interviews recorded.

Three research assistants (two male and one female) conducted the interviews using the interview frame developed by the researcher. The research assistants recorded the interviews using their phones and sent the recordings to the researcher. These research assistants were chosen because they are familiar with the study area and speak the native language.

3.3 Data analysis

Content analysis and thematic analysis were used to analyse the data based on the study objectives and research questions. Data coding was used and a matrix for the various data in relation to study objectives was generated. Since the interviews were also recorded, the recordings were well listened to so that important information that may not have been written down by the research assistants in the questionnaires was picked up and used for this study. The recordings were also to help bring clarity and correct any issues during translation from English to Rutooro and Rutooro to English during interviews, because during translation there could be misinterpretations and changed context of the question and the response. Since the researcher was situated in Iceland at the time of data collection, the questionnaires were scanned and sent to the researcher via email. To get a better meaning and understanding of the notes taken during interviews the main researcher remained in contact with the research assistants in order to clarify any unclear response that might have occurred.

3.4 Demographics information of the respondents

The study was conducted with 25 respondents in Nyantungo Subcounty, Kyenjojo District. The interviewees were 14 men and 11 women, between 26 and 60 years old, with an average age of 45 years. The average household size is six people with the smallest household consisting of three persons and the largest of 10 persons. The interviewees had different education levels; primary 11 respondents (five males and six females), 10 respondents secondary level education (seven males and three females), and four had tertiary education (two men and two women). Demographic data segregated by age group, marital status, household size, education level and gender is displayed in Table1 below.

Table 1. Demographic data of the respondents in the study.

	Demographics	Men	Women	Total
Age groups	25-45	8	7	15
	46 and above	6	4	10
				25
Marital status	Single	2	0	2
	Married	11	8	19
	Widow	1	3	4
				25
Household size	Small	8	3	11
	Large	6	8	14
				25
Education level	Primary	5	6	11
	Secondary	7	3	10
	Tertiary	2	2	4
				25

4. FINDINGS

This section presents the results of this study on climate-smart agriculture in Nyantungo Subcounty as the farmers struggle to mitigate the impact of climate change and the declining soil fertility that is affecting the agriculture sector. Section 4.1 revolves around the climate-smart agriculture technologies that are being implemented by smallholder farmers, and sections 4.2 and 4.3 revolve around the benefits and challenges affecting adoption of climate-smart agriculture technologies by smallholder farmers in Nyantungo Subcounty and Kyenjojo District based on their reported experience.

4.1 Crops cultivated and climate change awareness

The findings indicate that maize (corn), Irish potatoes, beans, bananas, cassava, groundnuts, sweet potatoes and various vegetables are the major food crops cultivated for food security, though when the harvests are good the excess is sold off for income. All the interviewees were at least growing two or three of these crops. Furthermore, 16 respondents and five respondents had coffee and tea plantations, respectively, that were mostly commercial or cash crops. The high number of respondents growing coffee was not a surprise as the government of Uganda under the National Agricultural Advisory Services (NAADS) has been promoting coffee growing by giving free coffee seedlings to farmers. It was established that 10 respondents were rearing cattle with a mixture of goats and pigs.

It was also established that all the 25 respondents said that they were aware of climate change. When asked whether they had noticed any changes in the climate in recent years, they all agreed that there where noticeable changes in weather and climate and that the changes in the climatic conditions of the area were evidenced by unpredictable seasons characterized by prolonged droughts, very high temperatures during the day and night, and unpredictable erratic rainfall that comes with strong winds and hailstorms. The strong winds and hailstorms that come through the area destroy a lot of property such as carrying away roofs of houses and schools, but they also destroy a lot of crops especially banana, maize and coffee. In some low-lying areas flash floods occur, destroying crops, and also result in the emergence of pests and diseases. In Table 2 below the different conditions that respondents had noticed over the years, which they relate to a change in climate, are shown.

Table 2. Conditions related to climate change that respondents had noticed over the years.

Conditions	**Observations**
Unpredictable rains	12
Prolonged droughts	9
Changing winds and hailstorms	2
High temperatures	2

The majority of the respondents indicated that it's these conditions that they attribute to climate change that have had devastating effects on their livelihoods. The majority of the respondents expressed themselves on the conditions above, but a 46-year-old male respondent put it out clearly below:

> *We used to receive rain in the planting season of March to May, this time the rains came late, and we are now in July with a lot of rain. Announcements have been running on radio that we expect this rain to continue to mid-August or September when we must be getting ready to begin planting for the August-November season. This means we shall have poor seasonal yields for the August-November season if the rains don't continue to November and this could lead to hunger and poverty.*

Other respondents noted that it's these conditions that have caused failure of crop yields from their farms. A 55-year-old female respondent stated that

> *This season I had planted two acres of maize and beans; however, due to the delay in the rains I have made a total loss. I will not even get the money I used for preparing the garden.*

Many more of the respondents also expressed their sorrow and pain due to poor rains that caused poor performance of their crops and are hence predicting periods of hunger due to low yields from the farms.

4.2 Gender differences in technology implementation

In relation to gender, respondents were asked whether there is a difference in the way female- and male-headed households differ in implementation of climate-smart agricultural practices or do their work on the farm. Of the respondents, 16 disagreed and said that there are no differences between male- and female-headed households, whereas nine respondents agreed that the differences are present. For example, women tend to select less labour-intensive practices unlike their male counterparts. These differences are related to technologies that are more labour intensive than others.

Table 3. Differences in the way male- and female-headed households implement CSA technologies.

	Yes, there is a difference	**No difference**
Males	3	11
Females	6	5
	9	**16**

However, on further analysis of the above results, it's evident that differences exist. In the findings, the majority of the respondents who disagreed are men and women who are married and work together with their husbands as a family. Also, because the respondents who disagreed may not have given it critical thinking during the interviews, as that five of the female respondents who disagreed that there is a difference are married and have husbands with whom they practice agriculture and hence they cannot see the differences. However, further differences can also be observed from the findings on specific technologies being implemented, see Table 4 below.

4.3 CSA technologies being practiced by smallholder farmers

This section presents the different technologies that the smallholder farmers practice to mitigate the impacts of climate change in the agriculture sector. The respondents identified the different technologies that they implement on their farms. These technologies have been clustered into the following five (5) categories: First of all, soil and water conservation technologies such as rainwater harvesting, runoff collection and storage, terraces and contours, use of cover crops and mulching; secondly, on-farm energy technologies like zero or minimum tillage and energy efficient saving stoves; thirdly, indigenous and scientific knowledge technologies such as the use of improved plant varieties that are tolerant to extreme conditions and fast maturing crops, and also utilising experience with regard to early planting options; fourth, integrated nutrient management technologies, for example intercropping with legumes and use of animal waste from cattle and goats; and fifth, carbon management technologies like agroforestry, fruit tree growing and fodder management. Table 4 below shows the popularity of these different technologies among the interviewees.

Table 4. Different climate-smart agriculture technologies implemented by the interviewees in Nyantungo Subcounty according to gender.

	Climate Smart Agriculture Technologies Used				
Gender of interviewees	Soil & water conservation	Energy conservation on farm	Knowledge (indigenous & scientific)	Integrated nutrient management	Carbon management
Men	12	11	10	9	10
Women	10	8	9	7	5
Total	22	19	19	16	15

According to the findings, many respondents implement different CSA technologies on their farms, as was shown by the multiple choices made by respondents during the interviews. For example, 22 out of 25 respondents interviewed implemented soil and water conservation technologies. I will now discuss each of these categories in more detail.

4.3.1 Soil and water conservation technologies

According to the results, 22 respondents (12 men and 10 women) were implementing climate-smart agriculture technologies on their farms. These practices are commonly practiced by both men and women, and include rainwater harvesting from the roofs and the collection of runoff water that is collected and stored in the ditches and trenches. The water is later used on the farms for irrigating crops in the typical rainfed agriculture system. However, the respondents express the challenges of not having big enough containers such as big plastic water tanks to harvest the rainwater.

Rainwater harvesting in the households is also an important activity. The rainwater is used in homes. Sometimes there is a breakdown of the borehole which is not easily repaired. Hence, availability of harvested rainwater saves women and children the task of fetching water from long distances and hence saving time for other tasks. The harvested rainwater is also used for watering animals in the dry spells when it’s available.

Mulching is a soil and water conservation practice, especially practiced by banana and coffee farmers using the cover crops, crop residues and other cover materials that are transported to the farms, especially wetland grasses. Planting of fodder crops such as Napier grass on contour bans, especially on the banana and coffee farms, also help to control soil erosion and maintain moisture. The majority of the 16 respondents that grow coffee mentioned carrying out mulching on their plantation. A male coffee farmer stated

> *... I planted Napier grass on my farm as fodder to feed my cows but now that I sold off cows, I use them [Napier grass] to mulch on the farm.*

4.3.2 Energy conservation on-farm technologies

From Table 4 it can be seen that 19 respondents (11 men and eight women) are practicing energy on-farm conservation technologies which include zero or minimum tillage on their farms. This involves digging a basin where the seeds are planted. This type of technology is reported most common with beans and maize farmers who indicate that when using this practice, you reduce energy and time used during land preparation. This was expressed by a 30-year-old male farmer in one of the interviews:

> *… this method of farming is good because you only dig where you are going to plant the seed; hence you reduce the amount of energy used and time during preparation of the garden.*

Furthermore, energy and time conserving on-farm technologies are not only applied to the land but also to the home. In this category, the majority of the respondents reported the use of energy efficient fuel saving stoves in their homes for cooking to increase the efficiency and save fuelwood, which is also scarce in the communities. An energy efficient fuel saving stove is an improved cooking stove that has one inlet and uses less fuelwood compared to the traditional three stones. One female respondent stated that:

> *...because all the forests have been cleared, now we have a problem of fuelwood for cooking and families have reached a stage of either utilizing a whole day for looking for fuelwood, but also having one meal a day because of lack of fuelwood. ... I paid about 50,000 Shs for labour to construct the energy efficient saving stove to help me save fuelwood but also to reduce the diseases associated with smoke.*

This woman is considered lucky to have been able to invest in an energy efficient fuel saving stove. The area got an opportunity from a non-government organisation for construction of energy efficient fuel saving stoves for all households in the community. However, the residents were to first contribute 50,000 UGX (about $14), which is a lot of money for communities where some households live below a dollar per day. Hence many households could not afford to pay for the stove. From the testimonies of the respondents who are using the energy efficient fuel saving stove, they are happy that they are using less fuelwood to cook a meal, less smoke is produced, and it is faster than when they were using the traditional three stones. But again, the option was not available to everyone because others failed to raise the 50,000 UGX that was required for counter funding.

4.3.3 Knowledge (both indigenous and scientific)

The majority of the respondents are using both indigenous and scientific knowledge in their agriculture. Scientific knowledge comes from scientific researchers such as crop breeders, field extension and companies who produce improved plant varieties that are both resistant to weather extremes such as prolonged drought and too much rain but also fast maturing crop varieties. The majority of the farmers acknowledged that some of the improved planting materials that are drought tolerant varieties are doing well, as stated by a 30-year-old male farmer:

> *…. We used to plant our local seeds back then, but it was not doing well because of unpredictable seasons, so we resorted to planting improved seed varieties, especially maize, beans and cassava that will resist drought, hence giving good yields.*

The respondent above expressed the importance of using improved seed varieties that are fast maturing and tolerant to drought.

The respondents also enlisted early planting, as early planting would help deal with the changing seasons of little rain, so that if the rains come on time then the crops can grow fast before the rain stops in the middle of the season. Several farmers indicated in the interviews that they plan and start preparing early enough for the planting seasons and that many times planting early would pay off if the rain came but then suddenly reduced in quantity during the season, as those who planted early would have good harvests.

The farmers also indicated that there has been a change in how they plan what to plant on the farms, especially what to plant during a specific season (crop planning) such as planting crops that require very little rain in the shorter season of March to May, unlike the September to November season. As one female farmer noted:

> *… most of the farmers around have decided to plant specific crops such as beans, groundnuts sweet potatoes, cassava and Irish potatoes for the short season of March to May because these crops require less rainfall amounts and have shorter maturity periods unlike maize (corn).*

4.3.4 Integrated nutrient management technologies

With regard to integrated nutrient management technologies, the findings show that 16 respondents were utilizing such practices (Table 4), for example intercropping of different crops like maize with beans, bananas with beans, cassava with groundnuts or beans, and banana and coffee. Intercropping increases the chances of getting some harvests of at least one crop during extreme seasons, or both when the season is good. In this very category, other respondents identified use of animal waste for fertilizing their farmland, especially the banana plantations. The majority of the farmers using this technology testified to its benefits and effectiveness, as stated by a female farmer in her mid-40's:

> *... our pieces of land have been cultivated for many years, season in. season out, hence it has lost its fertility and thus I apply animal waste from my cows and goats to increase my yields.*

This quote shows that farmers are appreciating the use of animal waste.

Other interviewed farmers equally acknowledged that they received increased crop yields from the farms where they practice intercropping and use of animal waste for fertilizing, coupled with other favourable conditions. The respondents stated that some of their neighbours were beginning to copy their good agronomic practices such as mulching, the use of animal waste for fertilizing the farmland, and agroforestry.

4.3.5 Carbon management technologies

As shown in Table 4 above, 15 respondents were practicing carbon management technologies that involved cultivation of legumes, agroforestry, fruit trees and fodder cultivation and management. Only five women were practicing this technology. There isn't a clear reason, but this could be because of land ownership since agroforestry requires a sizeable amount of land which most women do not have. The farmers agreed that cultivation of legumes such as beans and groundnuts is good for the soil. Agroforestry and growing of fruit trees on the farm was also considered beneficial for the land and the crops that are planted on it. The fruit trees grown included oranges, mangoes, jackfruits and other trees such as umbrella tree *(maesopsis emini),* mulberg fig (f*icus syscomoru*, sseban *(sesbania sseban*), and avocado usually intercropped with coffee and bananas. The majority of the farmers using this technology appreciated its benefits to their farms, including control of soil erosion, provision of shade to crops, windbreaks, fodder for the animals, and fuelwood. A male coffee farmer in his 60's stated it well:

> *... we have been encouraged to plant trees, especially fruits trees and other native trees on our farms by our extension workers. For me I have planted umbrella tree and mulberg trees to create shade and act as windbreakers for my coffee farm.*

From this quote it is clear that the farmer had been advised by the extension worker which shows that some farmers had listened to their advice and applied it on their farm. This is a sign that extension workers have a role to play in CSA technology adoption. The majority of the respondents were happy with agroforestry as a good practice, especially coffee farmers because it creates shade for coffee but also provides other benefits such as fruits, fuelwood for cooking, and timber. Farmers with substantial pieces of land have planted many trees. Another coffee farmer stated that:

> *… these trees are not only providing shade for the coffee farm, but act as windbreakers, provide fruits such as mangos, avocados, jackfruits, but also timber and firewood for cooking.*

4.4 Benefits of CSA technologies for smallholder farmers based on their experience

When respondents were asked about the benefits and effectiveness of climate-smart agriculture technologies based on their experience, the majority of the farmers who were using the different technologies agreed that the technologies were beneficial and effective in improving crop productivity and yield, but also in improving the environment and micro-climate modification.

4.4.1 Increased crop productivity and yields

The majority of the respondents indicated how climate-smart agriculture technologies had led to increased crop productivity and had increased the yields from their farms. Of the 22 respondents who implemented soil and water conservation techniques on their farms, 20 respondents were certain that soil and water conservation coupled with other practices improved crop productivity, and hence increased yields. The farmers noted that the practices helped to retain moisture and nutrients in the soil that makes it favourable for plants to grow.

The respondents indicated that the potential of the technologies, especially mulching, use of terraces, cover crops, agroforestry and fruit trees, all help to control soil erosion, and as the mulching materials decompose into the ground it gives the soil more nutrients. Intercropping with leguminous crops such as beans and groundnuts also helps the soil and thus all these practices result in improved soil fertility. Use of animal manure is also good for the soil, as indicated by the majority of respondents, especially those who have animals since it has helped them to increase production. A farmer in her mid-fifties justifies the case:

> *…ever since I started mulching, terracing and applying cow and goat waste in my banana and coffee plantations my harvest from coffee has increased and the sizes of the banana bunches have increased, too.*

The majority of respondents used improved plant varieties that are resistant to extreme conditions and quick maturity. This use had increased productivity and increased yields of the crops during different weather conditions. Crops such as beans and maize that are resistant to drought have helped to increase yield during the dry seasons. The farmers were supported with improved seed varieties of maize, beans and cassava cuttings from the government programme National Agricultural Advisory Services (NAADS) for planting. However, there were also are respondents who indicated that some of the improved planting varieties did not perform as expected during the drought periods.

Early planting was another practice identified by the majority of respondents that has contributed to increased yields of crops, especially with the onset of rainfall. The respondents suggested that when early preparations and planting is done and the rains come early, then there is an opportunity for getting good yields even if the rain stops or is reduced in the middle of the seasons. A few respondents, however, noted that not all these technologies are 100% effective in mitigating the impacts of climate change and the success of rain-fed agriculture still depends on the availability of rain for crops to do well.

4.4.2 Environment and microclimate modifications

According to the results, 20 respondents stated that agroforestry, i.e., the growing of fruit trees and other native trees on the farm, is a good practice that benefits the environment. The farmers stated that the trees grown on the farm help to reduce wind speeds and mitigate the impacts of hailstorms in the neighbouring areas. The respondents further indicated that agroforestry trees are sources of fruits, for example, mangos, oranges and guavas, and that the trees also provide farmers with timber and fuelwood for cooking and hence reduce pressure on the few remaining forests and wetlands in the area. They also reduce the time women and children have to spend looking for fuelwood. The respondents were happy with agroforestry and growing fruit trees especially mangos and avocados where some farmers have benefited from the government program of distribution of fruit tree seedlings.

4.5 Challenges of adopting to CSA technologies

According to the interviews, a substantial number of respondents identified several constraints to adoption of climate-smart agriculture technologies, including CSA being labour intensive, lack of financial/capital for investment in agriculture, inadequate extension services, and limited access to markets

4.5.1 CSA is labour intensive

According to the findings, CSA is said to be labour intensive. It requires a lot of labour on the farm to implement the different technologies and maintain them. For example, it requires about 10 men to work for five days to cut mulching grasses for 1 acre of banana plantation and transport it from the wetland to the farm. Another two days for the same number of persons are required to do the actual activity of mulching. It is obvious that all this cannot be done by one individual person but requires hiring labourers and paying them to do the work.

4.5.2 Financial resources for investment

The majority of the respondents mentioned a lack of financial capital as the major problem to adoption of climate-smart agriculture technologies. The respondents showed that they lack financial capital to invest in their farms to further implement these technologies, including money for buying bigger rainwater harvesting tanks and improved planting materials/varieties. If you have larger farms, money is necessary for paying for more labour. The farmers stated that the implementation of some activities, including mulching, requires funds which they don’t have, taking into consideration that the technologies are labour intensive.

The respondents noted that a lorry of mulching material/grasses from the nearest wetland costs 150,000 UGX (about $41) which many farmers cannot afford, depending on the size of the farms they are operating. The respondents further noted that they cannot get loans for investment in agriculture from financial institutions because the majority of the financial institutions require land titles as collateral to qualify for a loan, but many farmers do not have land titles. If they do, they are also afraid that their properties will be taken over by financial institutions if they fail to pay, based on the fact that the interest rates are high. Thus, lack of financial resources for investments limits the capacity to adopt these technologies.

4.5.3 Extension services

There are clear benefits that come with extension workers as they interact with farmers. They bring knowledge and skills to the farmers, and their advice when implemented improves agricultural productivity. According to the findings, respondents expressed gaps in extension services, including limited time spent with the farmers that resulted in inadequate knowledge and information about different agricultural aspects and therefore a constraint to adoption of climate-smart agriculture technologies. It was highlighted that farmers lack enough training and sensitization about the different technologies. Farmers then have to try these methods on their own which creates problems when the technologies do not perform as expected and scaling up within the communities becomes a challenge. The respondents are aware that the extension staff would be of help to them in the bid for adoption of these technologies by providing the farmers with training and practical skills through farm schools. A farmer in his mid-forties emphasised the need for extension services and added:

> *… the agricultural extension worker is usually moving around to monitor and train a few farmers who have benefited from government programs and once in a while he organises a meeting at the parish level where all farmers meet, usually for two hours.*

It was clear that the farmers need the training, but that two hours of training are not enough. Furthermore, the meetings need to be organized on a farm for hands on training. Through extension services a lot of advice and information on agriculture, markets, and climate change are shared with the farmers and that helps the farmers to gain experience and adapt to better methods of farming.

4.5.4 Access to markets

According to the findings, access to markets and the low prices they get for their produce is also a challenge for both male- and female-headed households in relation to adoption of CSA technologies. They must walk 8 km to the market to sell the produce after harvesting, especially banana, coffee, maize and beans since there is no ready market for some of the produce in the neighbourhood. As a result, farmers have sometimes to sell at a lower price in the neighbourhood, hence getting lower returns from the crops in which the farmer had invested a lot in order to produce. These low returns are demoralizing for the farmers to make investments in these labour-intensive technologies for example, maize production where the cost of a kilogram of maize on the market is sometimes very low compared to the investment on the farm to produce that kilogram.

5. DISCUSSION

The study set out to examine what climate-smart agriculture technologies are being implemented by the smallholder farmers in Nyantungo Subcounty, as well as to gain more insight into the benefits and effectiveness of CSA technologies, the challenges affecting the adoption of CSA technologies, and whether or not a difference could be observed between households headed by men or women in implementation of climate-smart agriculture technologies.

The study showed that many of the farmers were aware of climate change and that they were generally positive towards CSA technologies. They were willing to implement these technologies and do so up to the level they are financially capable of. The farmers' awareness and knowledge about climate change and the resulting impacts of these phenomena in the agricultural sector are a good starting point for examining the different interventions required to mitigate the impacts of the changing climate. Because the farmers are already aware of the problem, it will be less of a problem to change or further adjust the attitudes of farmers towards agriculture. Farmers are expected to easily adopt agronomic practices that are aimed at increasing productivity and environmental conservation. With more training and information sharing about climate change and its impacts, practical interventions such as CSA technologies, sustainable land management and restoration of degraded ecosystems could be introduced and fronted for adoption with support from government and partnerships with other organisations such as NGOs.

The farmers were found to be implementing different combinations/types of technologies on their farms, which is a positive stride towards impact mitigation in the agricultural sector. Some among the technologies being implemented in the area were highly used by the farmers in both male- and female-headed households, for example soil and water conservation, on-farm energy conservation, knowledge-based technologies (scientific and indigenous), integrated nutrient management, and carbon management in the order of preference. More male-headed households were engaging in many climate-smart agriculture technologies than women-headed households. Carbon management technologies involving agroforestry, fruit trees and fodder cultivation were the ones least practiced by women. This could probably be attributed to the land size required for agroforestry and fruit trees, and fodder cultivation is mainly practiced by those who own animals. In these communities, men usually own larger pieces of land than women and equally have more sources of income, which gives them an advantage over women in agriculture.

Farmers' priorities, preferences and choices differ from technology to technology depending on the land size required, cost of the specific technology, labour required and the intended use of the technology for the specific crops to be grown or cropping system (Khatri-Chhetri et al. 2017). The finding of this study are similar. Many farmers would choose a technology depending on what they know about it and the costs involved in implementation and maintenance. For example, many banana and coffee farmers were implementing soil and water conservation practices, especially runoff harvesting, mulching and agroforestry. As to energy conservation on the farm, the use of energy efficient fuel saving stoves was outstanding and knowledge-based technologies were used by substantially many women. Many women would acquire the energy efficient fuel saving stoves to help them maximise the fuelwood used and reduce smoke emission while cooking, which in turn reduces the risk of diseases that may result from smoke.

According to the findings, CSA technologies have had positive contributions to the increase in farm yields and crop productivity. Mulching, use of cover crops and application of animal waste were outstanding, especially for the banana farmers who applied them. From literature, it is clear that mulching and use of cover crops is good for reducing soil erosion, but also maintaining soil moisture, and on decomposition adds nutrients to the soil. Use of animal waste (manure) is important for the addition of nitrogen and the nitrogen balance in the soil. Hence, these conditions enhance soil fertility that in turn improves the productivity of the crops. Some technologies, such as agroforestry and fruit trees, are associated with environment and micro-climate modification benefits as wind breakers, improved infiltration, and control of evapotranspiration, among others. Other socioeconomic benefits of agroforestry and fruit tree practices include provision of fruits and fuelwood for the households.

According to the findings, climate-smart agriculture technologies are often labour intensive, requiring more labour and time to put them in place and later maintain them. With an average of six people per household according to the findings, and not all the family members participating in agriculture since some are school children, leaves few people to work on the farms, hence there is a labour gap. The findings also indicated strongly that there is no collaboration in the communities. Communities don't work together and learn from each other to implement these technologies on their farms. Much as some groups may exist, working together and group cohesion remains a challenge. This is contrary to research results from India, for example, where farmers have started to work together to implement agriculture practices (Tripathi & Mishra 2017).

Farmers need to be encouraged to work together and to copy knowledge from their neighbours. This would help in adoption of CSA technologies.

Financial resources for investment are inadequate or missing in the communities according to the findings. There are financial institutions where loans can be acquired, but there are stringent requirements for the loans such as collateral or security which farmers cannot usually afford. Also, the interest on loans is so high that people fear to lose their property to financial institutions if they are unable to pay. Access to affordable financial credit services is important for boosting the agriculture sector, where farmers could access affordable credit for investing in the different technologies. Affordable financial credit services determine the preference and willingness to pay for a given choice of technology. Most of the farmers in Nyantungo Subcounty and Kyenjojo District are low income earners mostly producing for substance consumption and selling the excess for income. Thus, these farmers cannot afford to go in for high CSA technologies such as crop insurance or hi-tech irrigation systems, so their choices are more of the low-cost and site-specific technologies.

Extension services are a key component in the agricultural sector. It is from extension services that farmers acquire new skills and knowledge in the field, for example about new crop varieties, good agronomic practices, pests and diseases, timely climate information and how to foster adaptation to the changing climate. Access to extension services helps to change the attitude of farmers towards farming and helps them make informed decisions (Tripathi & Mishra 2017), especially farmers that are in constant contact with the service providers as compared to other farmers who are not (Murage et al. 2015). This is probably because farmers receive direct and accurate information about climate change, CSA technologies and other better agronomic practices which will improve the farmers' performance if well implemented. With calls for extension services, it should be noted that climate change is a new phenomenon that many people, including extension workers, need training on, so that they will be able to deliver quality information and intervention suggestions to the farmers.

As to the gender perspective, this study showed that also in Uganda differences exist between how female- and male-headed households work and implement CSA technologies on their farms, and also when it comes to adoption options of whichever practices. From the findings it seems that male-headed households are working with many more technologies than their female counterparts. This could possibly be attributed to financial resource limitations for investment in agriculture since women have low income inflows compared to men. The women in the study, for instance, had smaller pieces of land than the men, which means less crop surplus, while it also made it harder for them to apply some of the CSA technologies such as practising carbon management technologies. The land tenure system, i.e. access and ownership of land, is also a factor influencing production, where in these communities very few women own land. The labour intensiveness of these technologies also acts as a disincentive to women trying to change and adopt CSA technologies (Jost et al. 2016). According to Wekesa et al. (2018) gender is still a major limiting factor to adoption and implementation of CSA technologies due to the continued practice of customary gender roles to date. While the current study found that both men and women use a range of CSA technologies, it also became clear that the women in the study implemented carbon management technologies less often than men. The results therefore partially support Wekesa et al.'s (2018) findings. Since the female-headed households have access to smaller plots of land than the male-headed households, gender may be one of the restricting factors when it comes to the adaptation of more advanced CSA technologies

6. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, climate change is real and already at the doorsteps of many households. It is already affecting the agricultural sector from which many people derive their livelihoods. From the results of this study, it’s clear that many farmers are aware and affected by climate change and its impacts, such as unpredictable seasons, prolonged droughts, pests and diseases resulting in reduced farm yields which greatly impact their livelihoods. As per the findings, farmers are trying to adopt to different technologies to mitigate the impacts of climate change. However, the challenge seems to be larger than what the farmers can handle on their own. Addressing the challenges faced by the farmers as revealed in the findings of this study will help to amplify the understanding of climate-smart agriculture technologies in communities, hence fostering selection of different technology choices and their adoption. Improving the financial credit services for farmers and encouraging farmers to work in groups where savings and credit could be conducted, could be a quick solution. From the overall analysis, more needs to be done for farmers to help them to fully adopt and optimize CSA technologies and hence get greater benefits from agriculture that will improve their standard of living. As farmers continue to practice different interventions all is not lost; farmers are still hopeful that government support will materialize through provision of better extension services and financial credit services, and more investment in climate-smart agriculture technologies that can better the mitigation of climate change impacts, thus increasing yields and promoting food and income security in the households.

Some recommendations based on my findings:

- The government should help provide water for production to make irrigation possible so that farmers can irrigate their crops all year round. This is possible with the government providing small irrigation systems in the communities but also subsiding the agricultural inputs required for irrigations.
- Creation of an agricultural fund to provide accessible and affordable financial credit services to farmers, in conjunction with farmer organization and microfinance institutions through reducing interest rates for agricultural loans.
- Farmers should organize themselves in groups for proper collaboration and easy access to extension services, financing and bulk marketing of their crops/yields for better prices. That farmer organizations formed by the farmers and extension workers can receive thorough training in organization dynamics and group cohesion is emphasized, so that through these farmer organizations farmers can access both extension services, market services and financial support.
- Strengthening of existing extension services at subcounty level to provide timely extension services including trainings, outreach farm schools, and information on markets and modern farming practices. The government can provide motorcycles and adequate fuel to help the extension workers reach the rural farmers.
- The government should embark on more community awareness raising and sensitization on the importance of climate-smart agriculture and different CSA technologies. Extension services need to encourage more women to participate in the training

programs. Furthermore, emphasis should also be put on addressing the limiting factors such as access and ownership of land in addition to financial resources for women to invest in agriculture.

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APPENDICES

APPENDIX I: INTERVIEW GUIDE FOR HOUSEHOLD INTERVIEWS

I am ………………………………………………………. a research assistant collecting data on behalf of Richard Rubongoya who is in Iceland for UNU-Land Restoration Training programme and because is not here to do the research, I will send him the data from this interview. He is conducting a research on climate change and would want to know how much farmers in Nyantungo Subcounty are occupied by this and whether they are adjusting their farming procedure because of change in climate. You have been identified to as a key stakeholder as a farmer to provide me with information to accomplish this study. This is therefore to request you to provide information by answering these questions and the information provided to me will be kept confidential and will be used for this research alone.

Background information and socio demographic characteristics.

Gender (*Tick what is applicable*)

a. Male …… b. Female……

3. Age
a) 20 – 30 b) 31 – 40 c) 41- 50 d) 51-60 e) 61or older

4. Marital Status.
a) Married b) Single c) Divorced d) Never married

5. What is the composition of your household membership in terms of size?
a) Boys (0-17 years) ……………
b) Girls (0-17 years) …………….
c) Men (18 - 60) …………………
d) Males (18 - 65) ………………..
e) Old people (61+)………………

6. What is the education level of the household head?
a) No education
b) Primary
c) Secondary
d) Tertiary (Diploma training, University)
e) Others (specify..............)

7. Can you tell me a bit about your farm?...
………………………………………………………………………………………………………

7(a) what things would you say go well on your farm?..

……
…
……
….
8.This research is about climate change, have you heard about climate change?
....
......
……
9 a. Do you notice any changes in climate in the past years.? ……………………………………….
……
...
b.   if YES. Please name the changes you have noticed
…………………………………………………
…………………………………………………..
………………………………………………….
10. What are the main problems you are facing/ running into on your farm?
……………………………
……
……
……

Climate-smart Technologies being used on farm

11. Have you heard about climate-smart agriculture? (***if never had heard about CSA then the interviewer explains what it is)***
……
………
……
..
……
……
12. What Climate-Smart Agricultural technologies do you use on your farm?

- Rainwater harvesting/runoff harvesting – for watering animals & use in gardens
- Irrigating crops (Drip Irrigations)
- Increased intercropping and growing of legumes on farm
- Mulching of gardens
- Use of drought tolerant variety seeds
- Use of animal manure from cattle, goats, pigs & chicken
- Agroforestry use fruit trees, shrubs, fodder
- Early planting
- Soil & water conservation structures
- Fertilizers
- Energy saving stoves for cooking
- Others mentioned………………………………………..

IMPACT

1. How would you describe the impacts of droughts on your agricultural activities? In what ways, if any, does this impact livelihood?
 …………………………………………………………………………………………
 …………………………………………………………………………………………
 …………………………………………………………………………………………
2. Are there any other severe weather events that are of influence on your agricultural activities? Can you come with an example?
 …………………………………………………………………………………………
 …………………………………………………………………………………………
3. Are there differences in how female and male farmers work on their farms? ....……………………………………………………………………………
 …
4. If there is no difference in planning/working styles, were they there 5, 10, 15 years ago?
 ………………………………………………………………………………………..
 ………………………………………………………………………………………..
5. Can you provide examples, if any, of how the on-farm practices have helped to produce food with change in weather & climate?
 …………………………………………………………………………………………
 …………………………………………………………………………………………
6. Contributed CSA practices to conservation of the environment and enhanced sustainable natural resource utilization?...
 …………………………………………………………………………………………
 …………………………………………………………………………………………
 ………………………………………………………………………………………
7. How CSA practices iImproved food production and livelihoods?
 …………………………………………………………………………………………
 …………………………………………………………………………………………
 ……………………………………………………………………………………
8. What are some of the benefits of the agricultural technologies/practices you have been using?
 …………………………………………………………………………………………
 …………………………………………………………………………………………
 ………………………………………………………………………………………
9. What are some of the disadvantages of the agricultural technologies/practices you have been using?
 …………………………………………………………………………………………
 ………………………………………………………………………………………
10. What are farmers doing to improve their productivity on-farm in the community?
 …………………………………………………………………………………………
 …………………………………………………………………………………………
 ……………………………………………………………………………………

11. What are the main problems that prevent you from adopting climate-smart agricultural activities?
……………………………………………………………………………………………
……………………………………………………………………………………
12. Do you think that adopting to climate-smart Agricultural technologies /Practices would change farm/household dynamics? For example, division of labor, time spent in the field, decision making, kind or quantity of inputs?
……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………
13. Do you think these Climate-smart Practices have improved food production and livelihoods?
………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………

STRATEGIES FOR ADOPTATION

14. What initiatives have been successful in reducing impacts on livelihoods & environment?
……………………………………………………………………………………………
……………………………………………………………………………………………
15. What initiatives have been unsuccessful according to your experience?
……………………………………………………………………………………..
16. What would need to change for you to be able to adopt particular climate-smart practice?
…………………………………………………..
……………………………………………………………………………………………
…………………………………………………………………………………
17. What options are currently available to combine both adaptation and mitigation options in the agriculture sector?
……………………………………………………………………………………………
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18. Ideally, what needs to be done for smallholder farmers to adopt to climate-smart agricultural practices widely?
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19. How would you describe the policy mechanisms in place or needed to foster the adoption of climate smart agricultural technologies utilization by the small holder farming communities?

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