Journal of Resources Development and Management www.iiste.org
ISSN 2422-8397 An International Peer-reviewed Journal
Vol.13, 2015

Smallholder Farmers' Practices and Understanding of Climate Change and Climate Smart Agriculture in the Southern Highlands of Tanzania

Gwambene, B.[2] Saria, J. A.[1] Jiwaji, N.T.[1] Pauline, N.M.[2] Msofe, N.K.[1]
Mussa, K.R.[3] Tegeje, J.A.[3] Messo, I.[1] Mwanga, S.S.[2] Shija S.M.Y.[1]
1.Open University of Tanzania
2.Institute of Resource Assessment (IRA), University of Dares Salaam
3.Sokoine University of Agriculture

Abstract
Adverse effects of climate change and variability remain to be a major threat to smallholder farmers and rural livelihoods. It posed a challenge of developing innovative technologies to improve rural livelihoods, environmental conservation and ensuring adoption of such technologies. Climate-smart agriculture (CSA) is used as a mitigation and adaptation option to reduce the negative impacts of climate change and improve agricultural productivity. To achieve the desired objectives, CSA requires a complete package of practices that increase productivity and income, build resilience and reduce green gas emission. However, adoption is largely dependent on farmers' understanding, preferences and their capacity and willingness to practice. The study explores smallholder farmers' understanding of climate change impacts and their proclivity on climate smart agricultural practices. In engaging with smallholder farmers, a range of methods was used, including focus group discussions (FGD), key informant interviews (KI), household questionnaire survey and field observations. Results indicate that less than half (26%) of smallholder farmers interviewed have low knowledge on climate change in the study area, however, they are adapting and coping with the impacts of climate change. The low knowledge, coupled with the low ability to effectively adapt to the impacts of climate change, might have contributed to reduced agricultural yields. Developing appropriate and feasible climate smart and resilient agriculture practices, is a pre-requisite towards improving food security and income to smallholder farmers. The study suggests the need to consider appropriate and sustainable local-based technologies to increase production. The local-based knowledge and technologies are cost effective, easy to adopt and can be easily out-scaled to other communities within the region. We conclude that the availability of improved local-basedtechnologies alone is not a sufficient condition to bring about the change and transformation among smallholder farmers. Effective institutions and sustained policy support play a significant role in the adoption of CSA practices. There is an urgent need for scientists and users to co-produce the climate information and CSA practices so as to ensure action-oriented recommendations. Therefore, establishing an enabling local environment, including by supporting strong and innovative rural institutions, to increase the uptake of good practices are indispensable.
Keywords: Climate change, climate smart agriculture, Southern Highland, smallholder farmers and perception

1. INTRODUCTION

Climate change and variability pose a great threat to food security and income of millions of people around the world. Changes in weather patterns have reduced crop harvest, increased food insecurity and malnutrition as well as poverty (Gwambene, 2011; URT, 2014). Its impacts are experienced through an increasing number of seasons without enough rainfall, rainfall peak season ending earlier than normal, poor rainfall distribution within the seasons and change in temperature (Aune, 2012; Komba and Muchapondwa, 2012; URT, 2014; Philip et al., 2015; Coulibaly et al., 2015).

Deforestation and unplanned land-use change triggered by increasing extraction of the natural resource base have increased people's vulnerability to the impacts of climate change and variability (Antle, 2009; Gwambene, 2012; CCAFS 2014). The demand for food, fiber and fuel results in biodiversity loss and decline in the productive capacity of ecosystems, which have negative implications on food security and income, especially to the rural poor (Nyanga et al., 2011; IDB, 2014).

Agriculture is the sector most vulnerable to climate change in Tanzania, and yet accounts for about 14% of greenhouse gas (GHGs) emissions, which are directly responsible for climate change (IDB, 2014). Nonetheless, smallholder farmers can play a major role in addressing climate change impacts by enhancing the capacity of soils and biomass to sequester GHGs through adoption of climate smart agriculture (FAO, 2010; Aune, 2012; Taneja et al., 2014). Climate smart agriculture aims at attaining the so called "triple win interventions". These interventions must increase agricultural yields (food and income security); make agriculture more resilient in the face of climate extremes (adaptation), and increase the ability of the farming systems to sequester GHGs, particularly carbon dioxide (mitigation) (FAO, 2010).

Developing appropriate and feasible climate-smart and climate-resilient agriculture practices is perceived to reduce hunger and improve food security and income (CCAFS, 2014). Transforming existing agriculture systems into climate-smart systems to negate the impacts of climate change, is necessary in order to address these emerging and unavoidable challenges (CCAFS, 2014). The important option is to build sustainable food systems, improve productivity and income of smallholder farmers. Agricultural intensification through improved technologies needs to consider farmers' response to new technologies and the extent to which these technologies had been adopted (Haule et al., 2010, Coulibaly et al., 2015).

Climate-smart Agriculture interventions are location specific, and to a large extent their adoption needs to be well-suited to users in terms of willingness, ability to practice, knowledge and their investment capacity (Taneja et al., 2014). An assessment of farmers' preferences and their willingness to adopt climate-smart interventions needs to align with government policies and institutional arrangements for large scale adoption of climate-smart agriculture. This study examines smallholder farmers' perception of climate change impacts and their preference on climate smart agricultural practices in the breadbasket areas of the Southern Highlands of Tanzania.

2. MATERIALS AND METHODS

2.1 Study Areas

The study was conducted in two Districts, namely Sumbawanga Rural (Rukwa region) and Kilolo district (Iringa region). The two Districts are among the major food crops producing districts in their respective regions in the southern highlands. The study districts were selected from the five project District basing on the representativeness in terms of biophysical characteristics, vulnerability to climate change, accessibility of the area and socio-economic activities. Such factors facilitated in understanding and drawing the conclusion and recommendation on the subject matter in the project area.

Kilolo District has three distinctive landscape zones (highlands, midlands and the lowlands), having different climatic characteristics. The highland zone is characterized by mountainous and undulating topography with an attitude of 1600 – 2700m above sea level. The annual rainfall in the zone is between 1000 to 1600mm and the mean temperature of 15ºc and below especially between June to September. This zone is famous in agricultural production of various crops, like Pyrethrum, Coffee, Maize, Beans, Peanuts, Wheat, Tea, Irish potatoes, various vegetables and different fruits. Livestock keeping is also practiced especially for dairy cattle under zero grazing. The midland zone is characterized by scattered mountain hills and flat areas with swamps and ponds with an altitude of 1200 – 1600m above sea level. The annual rainfall is between 600 – 1000 mm while the mean temperature is between 15 - 20ºC. The zone is favorable for agricultural production of crops like Tobacco, Sunflower, and Maize, Tomatoes, Sweet potatoes, Beans, Simsim, various green vegetables and fruits like Peach, Apples, and Peaches. Also livestock keeping is practiced especially for Diary Cattle, Sheep, Dairy Goats, Pigs and Poultry. The lowland zone lies between altitudes of 900 -1200m above sea level. The zone experiences a scarce rainfall of 500 – 600mm annually, and a mean temperature of between 20 -30ºC. Due to its flatness and presence of Ruaha and Lukosi Rivers, the zone is more favorable for irrigation agriculture.

Sumbawanga district, one of several districts of the Rukwa Region is bordered to the south by Zambia and to the northwest by Nkasi District. The district experiences high rainfall from mid November to Mid May, with the annual rainfall ranging between 100 in the semiarid area and 1300 mm in the highlands. The maximum temperature is 24ºC to 27ºC and a minimum is 13ºC – 16ºC. The area is suitable for crop production and livestock, main crops produced include maize, cassava, beans and rice. Maize is mostly grown for both food and cash, making the district among the main maize producers in the region.

2.2 Data collection

Data for this study was collected from 62 randomly selected households and about 20 key informants and focus group discussion (FGD) in three villages of the Southern Highlands of Tanzania. The villages include Bomang'ombe (Kilolo District), Jangwani and Sandulula (Sumbawanga District). The study used a cross-sectional survey design, which constituted a collection of data from a stratified population of smallholder farmers at a single point in time. The method is important in assessing the prevalence of a phenomenon, problem, attitude or issue by taking a picture or cross-section of the target population. In order to have a good representation of all the relevant groups, purposive sampling techniques were used in selecting the respondents for FGD and key informant interview.

A structured questionnaire was administered to smallholder farmers to collect information on farmers' perceptions of climate change and variability impacts, agricultural practices adopted to ensure food security and willingness and ability to adapt CSA. In addition, the key informant interviews were conducted as part of in-depth interviews to acquire more information on the subject matter. This technique was used to acquire more information on the perception of smallholder farmers and the view of the key people in the community. A total of three FGDs, one in each village, were conducted. Besides, field observation was also used to collect additional data and used to verify some of the information collected.

2.3 Data Processing and Analysis

Data from the primary sources were verified, coded and analyzed using different qualitative and quantitative statistical software, including the Statistical Package for Social Sciences (SPSS) and a Microsoft office (excel) and trend and content analysis. The purpose was to explain the phenomena and detect any associations between the variables for making inferences about CSA practices and efficiency in the Southern Highlands of Tanzania. Descriptive statistics were used for comparison purposes on variables of interest to explain phenomena.

3. RESULTS AND DISCUSSION

3.1 Smallholder Farmers' Perception of and Knowledge of Climate Change Risks

3.1.2 Awareness on climate change

Respondents were asked to state whether they have ever heard about climate change. The results indicate that 84% of respondents reported that they have heard of climate change from different sources and the remaining 16% reported that they have not heard about climate change (Figure 1). Hearing about climate change does not necessarily guarantee understanding of climate change. It was thus important to establish farmers' understanding and perceptions of climate change. Farmers' perception of and knowledge on climate change and variability are important in understanding and assessing the strategies for reducing climate change impacts. The study found that lack of awareness and knowledge on climate change and adaptation strategies, and low adaptive capacity hinder adaptation to climate change. Antle (2009), Aune (2012), Komba and Muchapondwa (2012) argued that farmers' awareness on climate change, options for adaptation to climate change impacts and the factors influencing the choice of adaptation methods are correlated.

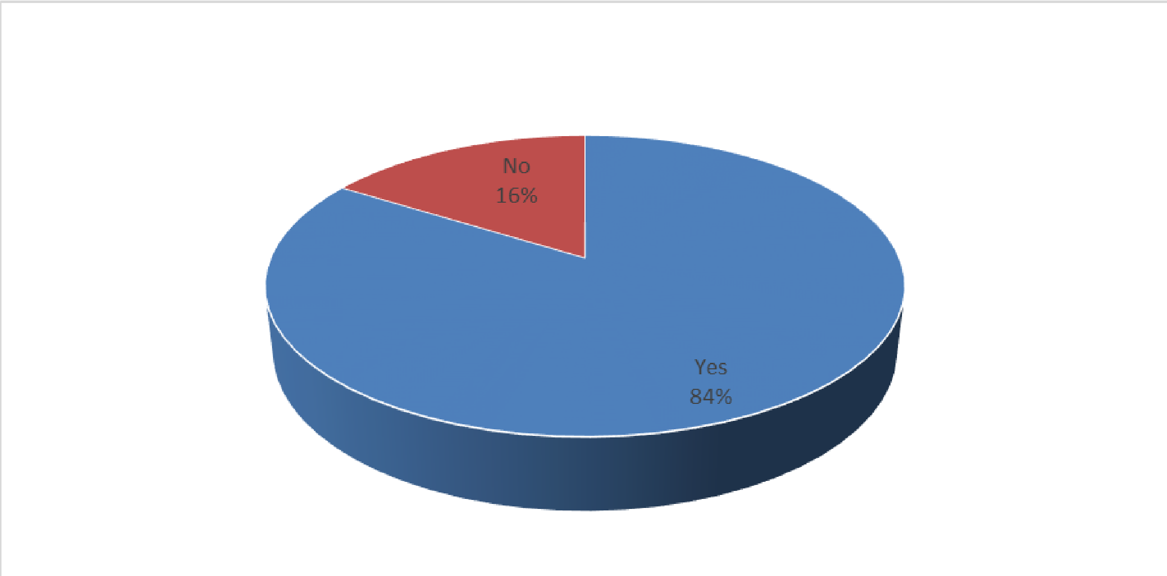

Figure 1: Proportion of smallholder farmers who reported to have heard about climate change

The study found that farmers received information on climate change through different ways. The main way used by many respondents was media (specifically radio), researchers, extension officers and NGO. Other methods include school, books, elders and witness; own observation, TV and newspapers as well as village meetings (Figure 2). Understanding the source of information is important for information dissemination. The commonest method can help to send messages to a large portion of the community in a shortest possible time. It is also easier to send the message using the commonly used method. For example radio was used by the AGRA Tanzania Environmental Policy Action Node to raise awareness on climate smart agricultural practices and Agriculture Climate Resilience Plan. The feedback on the matters confirmed the usefulness of the method.

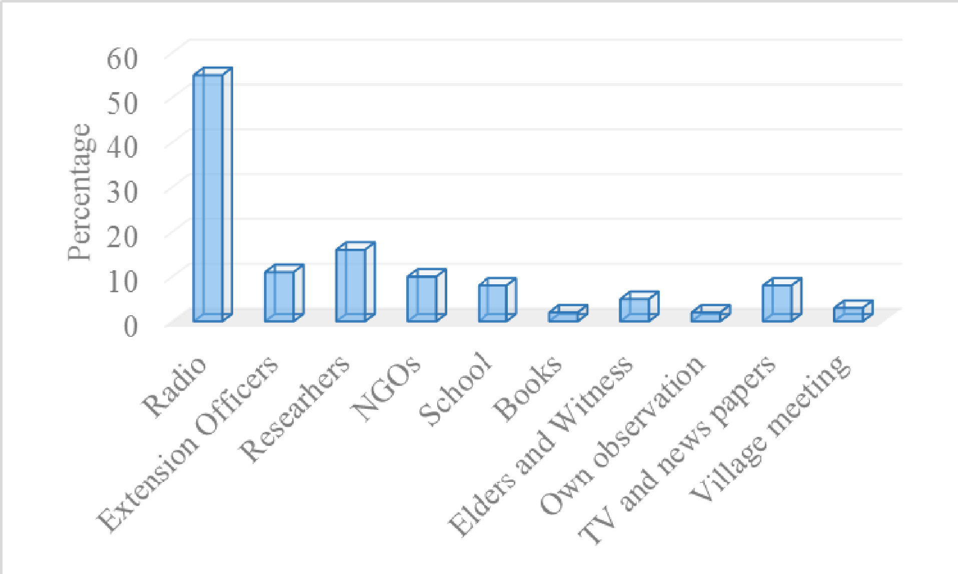

Figure 2: The source from which farmers heard about climate change

Extension services play an important role in information dissemination and scaling out of farming knowledge and technology. The study findings revealed that most farmers learn by observing the successful practices of others. Similar findings were also reported by Gwambene and Majule (2010) and Lamboll et al., (2011). Achieving and sustaining the adoption of climate smart agriculture requires intensification, extension and farming education that demonstrates relative benefits of various climate smart agriculture technologies. The extension services need to address and incorporate smallholder farmers to make use of the local knowledge and experiences essential for improving agricultural production, land productivity and improvement of income.

3.1.2 Knowledge about climate change

Climate change information and knowledge can help farmers make informed decisions on agricultural production. The results from the household survey indicate relatively high knowledge among smallholder farmers on climate change (Figure 3). However, about 57% of respondents had moderate knowledge and only 17% were highly knowledgeable on climate change. The remaining 26% of the respondents reported that they had no any knowledge on climate change. This was due to the fact that farmers are more impacted by climate change and tend to remember the events that affect their activities and they remain in their memories. Low knowledge on climate change contributed to low adoption of climate smart agricultural practices. The study revealed that most of the farmers who practiced climate smart agricultural techniques did not know the reason for practicing the methods.

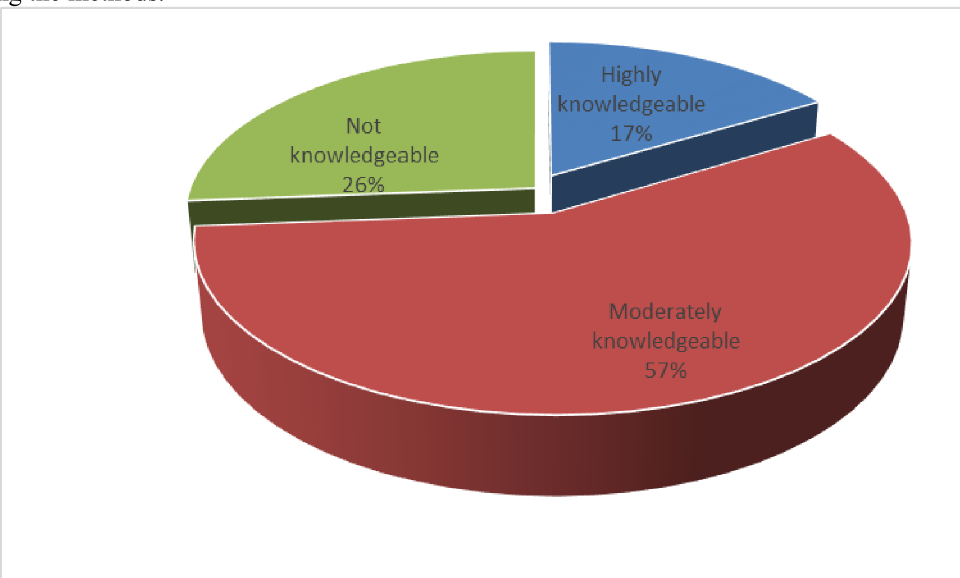

Figure 3: The knowledge of the respondents about climate change

3.1.3 Understanding of Climate change effects

The impacts of climate change on farming communities are experienced through reduced yield and household income. Basing on household survey climate change has numerous impacts on agricultural production and livelihood activities at household and community levels as indicated in Figure 4. The impacts of climate change were perceived to increase vulnerability to most of households. At the community level the effects of climate change and variability were revealed through food shortages as reported by 38.7% of the respondents, infestation of uncommon pests (30.6%), crop failure (24.2%) too much rainfall (24.2%), diminishing rainfall/drought (22.6%), disappearance of useful plant species (19.4%), diseases (9.7%), soil erosion (3.2%), wind (3.2%), deforestation, increase of temperature (3.2%) and loss of soil fertility. According to discussions with key informants, climate change and variability resulted in lower crop production, decreased land productivity and increased production cost.

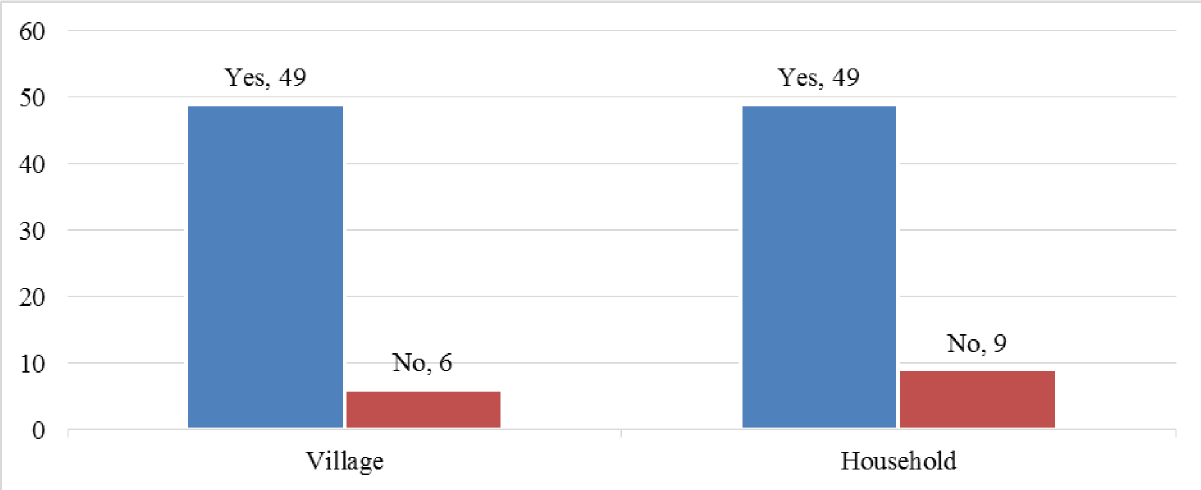

Figure 4: The effects of climate change on the village and households

Basing on household survey, climate change affects the household in different ways, including food shortages as reported by 29.0% of the respondents, crop failure (29.0%), infestation of uncommon pests (27.4%), too much rainfall (19.4%), diminishing rainfall/Drought (17.7%), and disappearance of useful plant species (12.9%). Other ways include crop diseases (9.7%), increased winds (3.2%), soil erosion, loss of soil fertility, low and high temperature, reduction of surface water and decrease of income.

The effects of climate change and variability remain to be a major threat to smallholder farmers and rural livelihoods (Antle, 2009; Aune, 2012; Komba and Muchapondwa, 2012). In response to these adverse impacts, farmers have to adopt through changing farming calendar, farming pattern, introduction of new crops and the like. Such measures help farmers to reduce the severity and survive from the impact resulting from climate change.

3.2 The CSA Practices and Adoption among Smallholder Farmers

The study revealed that smallholder farmers have adopted various agricultural practices to overcome several environmental problems such as diminishing soil fertility, climate change and variability etc. The aim is to enhance food security and improve household income. In all the study areas, smallholder farmers practice climate smart agriculture in their field as indicated in Figure 5. However, most farmers are not aware practices and the reason for practicing them. Basing on key informant interviews and household survey, farmers practiced the methods which are perceived to be feasible and can increase yield and food security. The study found that of all the CSA practices known, crop rotation received a high priority as 71% of the respondents reported to have adopted it (Figure 5). This was followed by other practices such as mixed cropping, terracing and livestock farming, each of which was reported by about 40% (multiple responses) of the respondents. Mulching and zero/minimum tillage received the lowest priority. It was further revealed that farmers have knowledge gained through experience. As discussed in other studies (Grabowski, 2011; Gwambene, 2011; Nyanga et al., 2011; Phillipo et al., 2015) farmers understand their environment and develop their practices through the observed environmental parameters that limit the practices. Developing an appropriate and feasible climate-smart and climate-resilient agriculture practice reduces hunger and improve food security and income (see also FAO, 2011). The most important option for smallholder farmers is to build sustainable food systems, improve productivity and income.

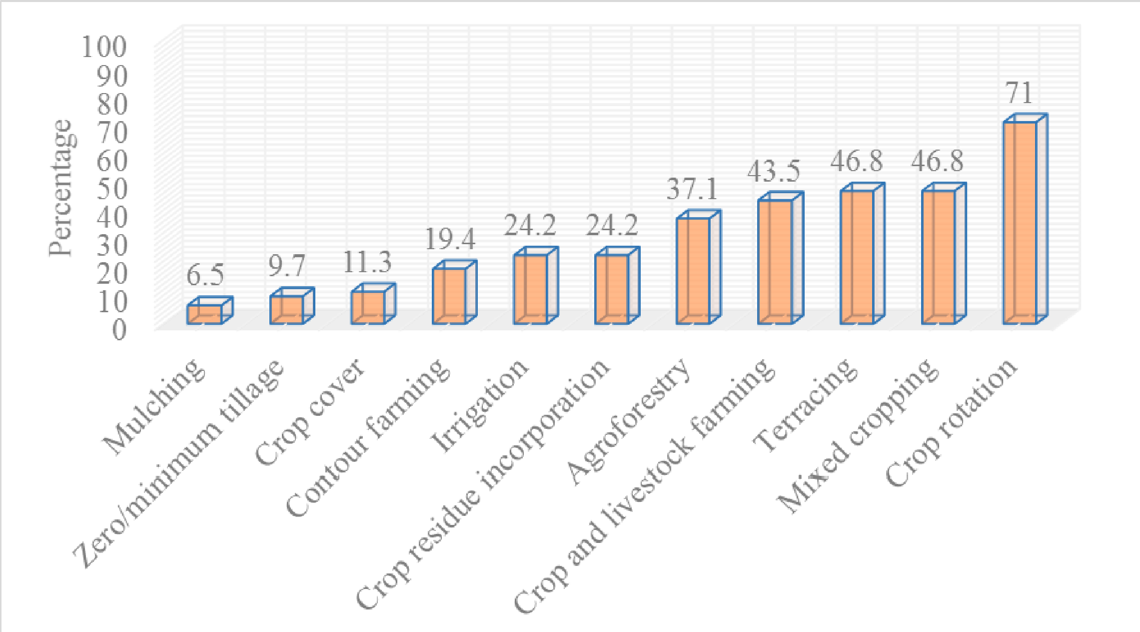

Figure 5: Household, Farming methods/ practice

Furthermore, the study found that more than 71% of the respondents practice climate smart agriculture as a traditional way of farming in the area, while about 24% were aware of the practices and understood the reasons for practicing the methods. This was also revealed by the number of years a particular CSA practice was put in use (Table 1). The assessment of local practices revealed the temporal variation in the practices in all areas. Most of the common methods were used for a long time compared to the perceived new practices. The practices such as crop rotation, terracing, managing crop residue and mixed farming are the most common methods that have been used for a long time by most of the respondents.

Table 1: Years implemented farming methods/ practice

Implemented farming methods/ practice	Years **(n=62)**							
	1-5		6-10		11-20		20+	
	n	%	n	%	n	%	n	%
Agroforestry	14	22.5	3	4.8	3	4.8	3	4.8
Zero/minimum tillage	4	4.8	-	-	2	3.2	1	1.6
Contour farming	4	6.4	3	4.8	1	1.6	2	3.2
Terracing	11	17.7	7	11.2	4	6.4	7	11.2
Irrigation	7	11.3	5	8.1	1	1.6	1	1.6
Mulching	3	4.8	2	3.2	-	-	1	1.6
Crop cover	2	3.2	-	-	1	1.6	3	4.8
Crop residue incorporation	4	6.4	2	3.2	5	8	1	1.6
Mixed cropping	8	12.9	9	14.5	8	12.9	5	8
Crop rotation	15	24.1	9	14.5	14	22.5	7	11.2
Crop and livestock farming	11	17.7	5	8	6	9.6	1	1.6

As shown in Table 1, some of the practices are more common and used for a long time, while others are just used for a short time. For instance, crop rotation is a common method used for a long time and is acknowledged for improving food security and income of smallholder farmers. The ability to address the production challenges and adoption of climate smart agriculture varies among smallholders farmers (See also Nyanga et al., 2011; Taneja et al., 2014). In most cases, farmers consider and prioritize food security improvements. Consequently, this may impose trade-offs between adaptation and mitigation goals. In enhancing the adaptive capacity of farmers it is therefore important to consider the farmers' perception and the ability and willingness to adopt for sustainability.

Although majority of the respondents reported to have adopted some CSA practices, only a few of them conceptualized the practices as a climate change adaptation strategy. These results show that there are other more important reasons for practicing climate smart agriculture other than adaptation to climate change. Basing on household surveys, key informant interview and FGD the main purpose of practicing CSA in the area was to increase household food security, improve soil fertility and increase crop yields as indicated in Figure 6. In practice, smallholder farmers are more concerned with food security and income to meet household basic needs. For the success and sustainability of the interventions among smallholder farmers there is a need to consider such factors perceived to be important.

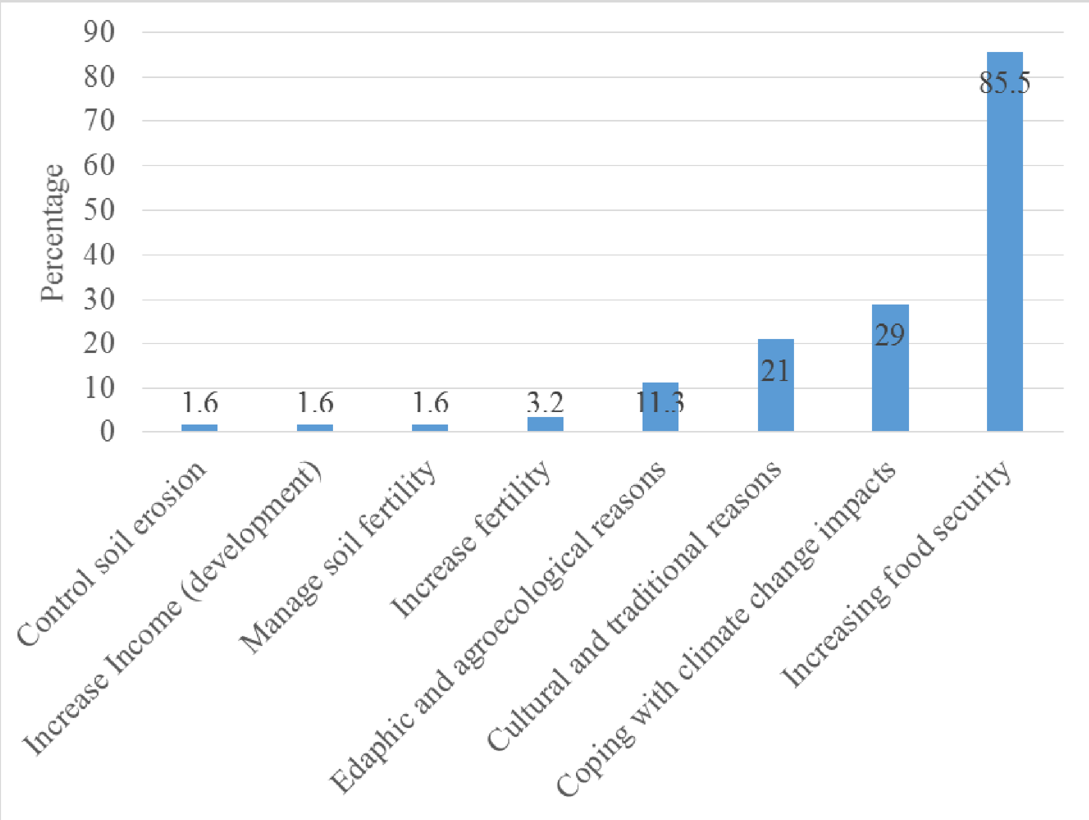

Figure 6: The main goal of practicing the farming methods

Increased farmer awareness of the benefits and training on land management could further enhance the incorporation of climate smart agriculture practices in their production system. This will need the radical and environmental change that includes scientific and socio-economic changes at the local and national level. Understanding the importance and the need for practicing climate smart agriculture can help in transforming the production systems in the areas. Such fundamental factors are important in adaptation to climate change, increasing smallholder resilience and reduce the impact of climate change and variability.

3.3 Willingness and aptitude to adopt CSA practices

Farmers were provided opportunity to indicate their willingness to adopt climate smart agricultural practices. The results indicate that most farmers were willing to adopt the practices and only a few respondents reported that they are not willing to adopt the practices (Figure 7) Basing on the key informant interview, those who are willing to adopt the practices indicated increased yield and improved soil fertility as the main drivers for their adoption. Such results indicate the importance of understanding the need of the community and their perception before the implementation of new interventions. Such results are in line with other studies in adaptation to climate change (Antle, 2009; Grabowski, 2011; Lamboll et al., 2011; Nyanga et al., 2011; Coulibaly et al., 2015). The studies suggested the importance and needs for considering local community perceptions in planning for intervention. According to these studies, local communities have knowledge developed for a long time in their surroundings through experience and practices which are important in developing adaptation and mitigation strategies. Consideration of their knowledge and experience is important for up and out scaling and sustainability of the interventions.

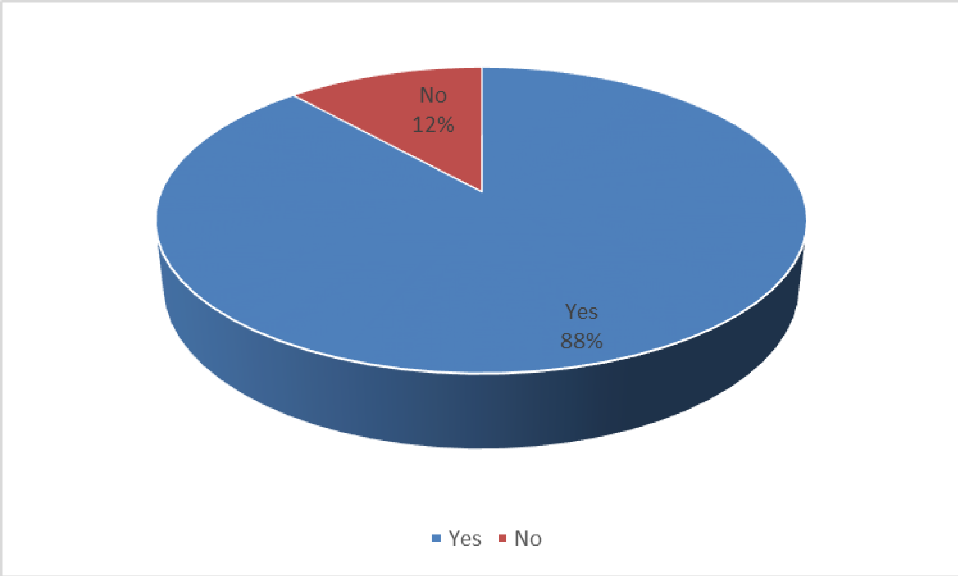

Figure 7: Willingness to adopt climate smart agricultural practices

The assessment of farmers' preferences indicates their devotion to adopt new technologies and interventions that would transform agriculture into a relatively more productive, higher-income, and improve food security. Through discussion with key informants, it was revealed that smallholder farmers are reluctant to adopt new technologies and knowledge in their production systems. Technologies that utilize crop diversity to ensure soil cover using cover crops, resiliency to climate change and those that minimize the adverse effect of mono-cropping, especially the build-up of pests and diseases were most preferred by smallholder farmers. These practices are acknowledged for scattering the risk and reducing a total crop failure as farmers are involved in multiple practices. However, tenure and land size in the area limited the adoption of the method that need large size of land or long term practices. Land ownership significantly contributes to adoption of climate smart agricultural practices. An analysis by FAO (2011) cited conservation agriculture, agroforestry, soil and water conservation as well as conservation grazing being a risk intervention where land tenure is insecure. This will need a clear land policy that provides right of owning land and secured land rights among smallholder farmers in promoting investments on land, such as adoption of soil conservation practices which conform to climate smart agriculture.

In assessing the willingness and ability of farmers to implement the practices, the results indicated that farmers are willing to practice the climate smart interventions and some have ability to practice while others have no ability. Figure 8 shows the variation in farmers' willingness and ability to adopt practices. The ability of most of the respondents was lower than the willing to practice, this may need to raise the farmers' ability to adopt the climate smart farming strategies and practices.

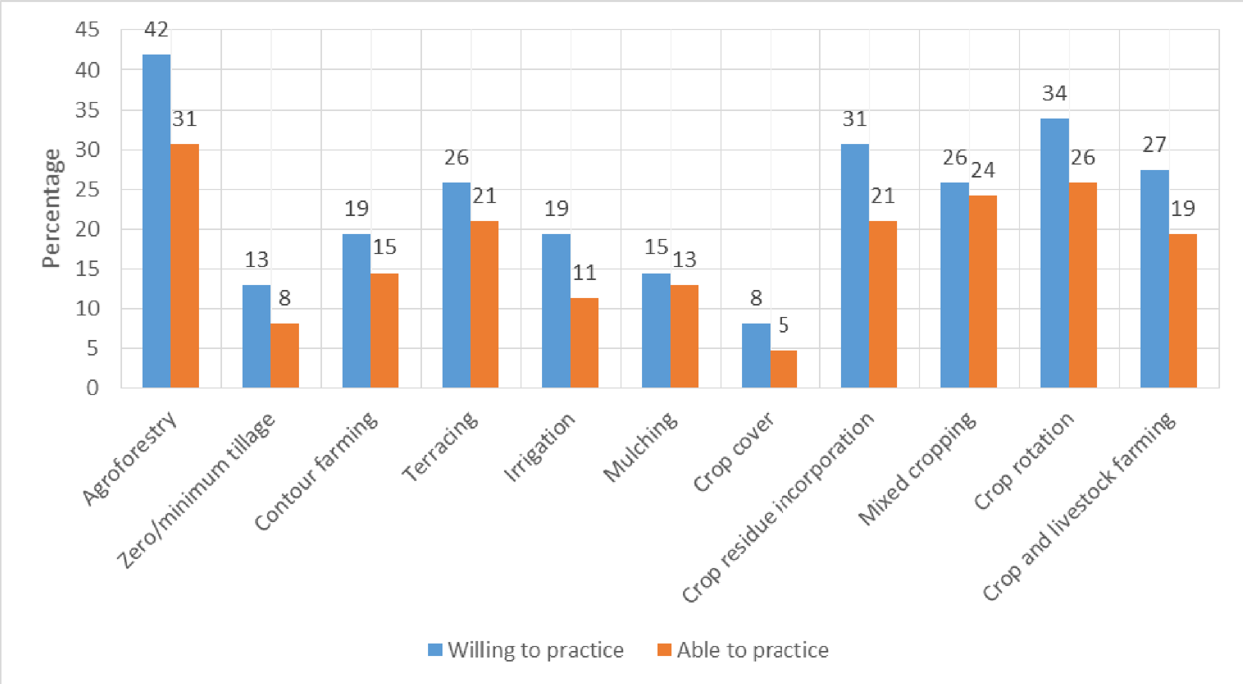

Figure 8 Farming methods/ practices: willing and able to practice

The low adoption of climate smart agriculture was associated with socio-economic, bio-physical and policy factors. The factors for low adoption of CSA practices by most smallholder farmers as also discussed in the literature (Nyanga et al., 2011; Taneja et al., 2014) include, but not limited to, a low degree of mechanization within the smallholder farming system; a lack of appropriate implements; insufficient appropriate soil fertility management options; inadequate and sometimes inappropriate technical information, limited/ poor access to credit. Other challenges are blanket recommendations that ignore the resource status of rural households; competition for crop residues in mixed crop-livestock systems; and the availability of labour and inadequate extension services. Figure 9 provides the reasons for not willing to adopt climate smart agricultural practices among the stallholder farmers.

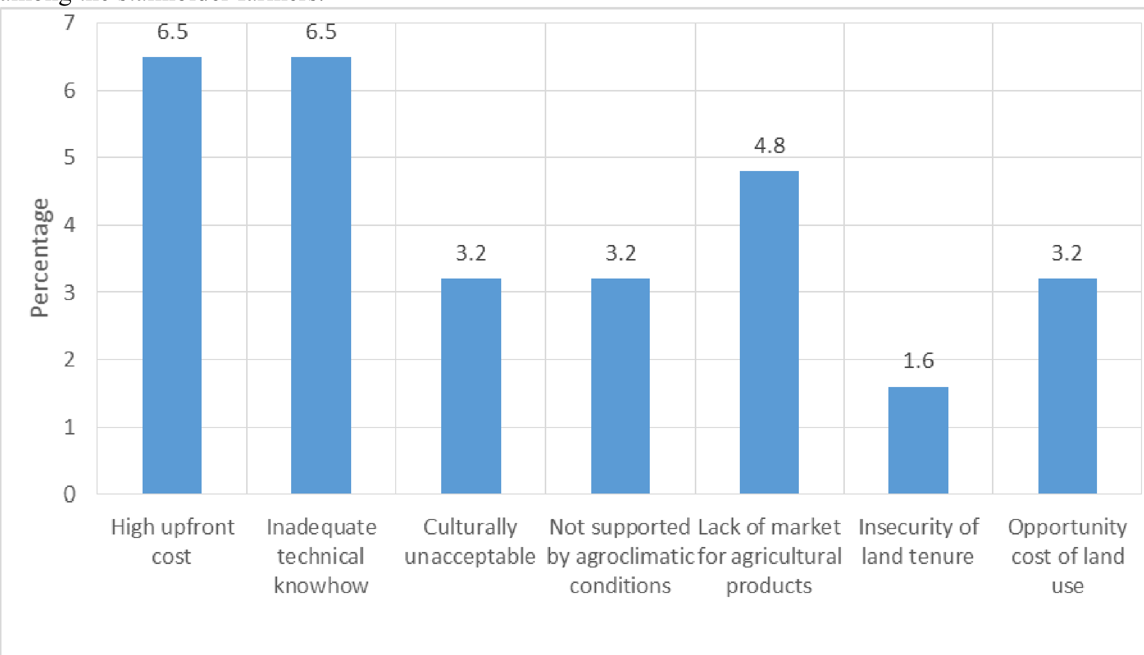

Figure 9: Reasons for not willing to adopt climate smart agricultural practices

Farmers will not invest all their resources if they are not assured about the outcome of the technology or practice. Adoption of new technology and practices in most cases is affected by the perceived opportunity cost of land use, high production cost and cultural aspects. This is supported by Shetto and Owenya, (2007), Nyanga et al., (2011), Komba and Muchapondwa (2012) and Coulibaly et al., (2015) farmers who recognize climate change impacts take some actions to cushion themselves against its adverse effect. However, such action is taken under some investigation and careful observation from others.

Improving livelihood and household income of smallholder farmers will need a combination of technology and social economic factors. Such factors include the availability of technologies, development of effective institutions and sustained policy support to bring the technologies within the reach of farmers. They may also include supporting strong and innovative rural institutions and farmers to increase the uptake of best practices and consider appropriate and sustainable technologies to increase production while taking into consideration local and traditional knowledge and practices.

4. CONCLUSIONS

This study has indicated that farmers are keen to adopt new technologies and interventions that would transform agriculture into a relatively more productive, higher-income, and lower-carbon activity. Farmers' knowledge on climate change is still low in the project area. However, farmers are adapting and coping with the ensuing impacts. Developing appropriate and feasible climate smart and resilient agriculture practices are perceived to increase food security and income. Increased farmer awareness of the benefits and training on land management could further enhance the CSA uptake among smallholder farmers. This will need to intensify extension education that demonstrates relative benefits of various climate smart agriculture technologies to stimulate their adoption.

Farmers' perception and socio-economic factors are important in developing a feasible and appropriate practice. Availability of new technologies alone is not a sufficient condition to bring about the change. Effective institutions and sustained policy support to bring the technologies within the reach of farmers play a significant role in the adoption of technology and practices. This will need to consider capacity building and ensuring that farmers fully understand the climate products and can apply climate information effectively. Establishing an enabling local environment that includes supporting strong and innovative rural institutions will increase the uptake of good practices. This will need to consider appropriate and sustainable technologies to increase production while taking into consideration local and traditional knowledge. The extension services need to address and incorporate smallholder farmers to make use of the local knowledge and essential experiences for improving agricultural production, land productivity and improve income.

ACKNOWLEDGMENTS

This paper was prepared as a contribution to the project entitled "Securing Small Holder Farm Production against Climate Induced Risks" which was implemented by Tanzania Environmental Policy Action Node with generous support from the Alliance for a Green Revolution in Africa (AGRA). The authors thank Dr. Evelyn Namubiru-Mwaura, the AGRA Coordinator for her coordination of the Tanzania Environment Policy Action Node and encouragement in writing this paper. The community from Sumbawanga and Kilolo Districts in the Southern Highlands of Tanzania for providing information and the extension officers for their inputs and help in organizing focus group discussions with farmers and key informant interview. We would also like to thank the following experts for their inputs, efforts, and support for the study: Mr. Baran Hintay from Open University of Tanzania, Mr. Michael Mwaisondola –the Kilolo District Agricultural irrigation and cooperative Officer and Mr. Kwileluye –the Sumbawanga District Agricultural irrigation and cooperative Officer.

REFERENCE

Antle, J.M. 2009. Agriculture and the Food System: Adaptation to Climate Change. An Initiative of the Climate Policy Program at RFF report available at http://www.rff.org/rff/documents/rff-rpt-adaptation-antle.pdf Accessed on June 23, 2011

Aune, J. 2012. Sustainable Agriculture and the Environment: Introduction to Agricultural Systems in Developing Countries, http://tinyurl.com/pe5nsfs Accessed on December 15, 2012

Climate Change, Agriculture and Food Security (CCAFS). 2014. Which climate-smart agriculture technologies are farmers willing to put their money on? http://tinyurl.com/njsd9s9

Coulibaly, Y. J., G. Kundhlande, N. Amosi, Tall A., Kaur H., Hansen J. 2015. What climate services do farmers and pastoralists need in Tanzania? Baseline study for the GFCS Adaptation Program in Africa. CCAFS Working Paper no. 110. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Food and Agriculture Organization (FAO). 2006. Agriculture and Consumer Protection Department. Rome, Italy Available from http://www.fao.org/ag/magazine/0110sp.htm (Accessed May 2015).

Food and Agriculture Organization (FAO). 2011. Socio-Economic Analysis of Conservation Agriculture in Southern Africa. REOSA Network Paper 02. Johannesburg, South Africa. http://www.fao.org/docrep/013/i2016e/i2016e00.pdf (Accessed May 2015).

Food and Agriculture Organization. (FAO). 2010. The Status of Conservation Agriculture in Southern Africa:

Challenges and Opportunities for Expansion. Regional Emergency Office for Southern Africa (REOSA) Technical Brief 03 www.fao-reosa.org.

Grabowski, P. 2011. Constraints to adoption of Conservation Agriculture in the Angonia highlands of Mozambique: perspectives from smallholder hand-hoe farmers. Michigan State University Press

Gwambene, B &Majule A. 2010. 'Contribution of tillage practices on adaptation to climate change and variability on agricultural productions in semi-arid areas of central Tanzania' Climate change, Agriculture, food security and human health, 9th European IFSA Symposium, 4-7 July 2010, Vienna (Austria) WS3.1 pp. 1300-1306.

Gwambene, B. 2011. Climate Change and Variability Adaptation Strategies: Implication of adaptation strategies on land resources in Rungwe District, Tanzania. LAP Lambert Academic Publishing, Saarbrucken Deutschland.

Haule, C.B.M., Mlozi M.R.S. and Mulengera M.K. 2010. Land Degradation and Smallholder Farmers' Response: A Case of Villages in the Southern Parts of Ludewa District, Iringa Region. Tanzania Journal of Agricultural Sciences (2013) Vol.12 No. 1, Pp 11-21.

Inter-American Development Bank (IDB). 2014. Climate-smart agriculture in Latin America: drawing on research to incorporate technologies to adapt to climate change / Nancy McCarthy. p. cm. (IDB Technical Note: 652) http://tinyurl.com/nd7zn49

Komba, C. and Muchapondwa E. 2012. Adaptation to Climate Change by Smallholder Farmers in Tanzania. Economic Research Southern Africa (ERSA) working paper 299. http://www.efdinitiative.org/sites/default/files/wp299_0.pdf Accessed on June, 2015

Lamboll, R., Nelson V and Nathaniels N. 2011. Emerging approaches for responding to climate change in African agricultural advisory services: Challenges, opportunities and recommendations for an AFAAS climate change response strategy. AFAAS, Kampala, Uganda and FARA, Accra, Ghana. Available from http://tinyurl.com/krxsk29 Accessed on July 15, 2013

Nyanga, P.H., Johnsen F.H, Aune J. B and Kalinda T.H. 2011. Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. Journal of Sustainable Development Vol. 4, No. 4; pp 73 – 85. http://tinyurl.com/nhokvkqAccessed June 2015

Phillipo, F., Bushesha M and Mvena Z S.K. 2015. Women Farmers' Characteristics and Perception towards Climate Change and Variability in Iringa District, Tanzania. Journal of Environment and Earth Science, Vol.5, No.8, 2015 pg 120 – 128. www.iiste.org

Shetto, R and Owenya M, Eds. 2007. Conservation agriculture as practiced in Tanzania: three case studies. Nairobi. African Conservation Tillage Network, Centre de Coopération Internationale de Recherche Agronomique pour le Développement, Food and Agriculture Organization of the United Nations.

Taneja, G., Pal B D., Joshi P.K., Aggarwal P K and Tyagi N. K. 2014. Farmers' Preferences for Climate-Smart Agriculture: An Assessment in the Indo-Gangetic Plain. International Food Policy Research Institute (IFPRI) Discussion Paper 01337. http://tinyurl.com/odfd7dcAccessed on June, 11, 2015

United Republic of Tanzania (URT). 2014. MKUKUTA Annual Implementation Report (MAIR) 2013/14.Ministry of Finance

World Agroforest Centre. 2011. Making climate-smart agriculture work for the poor Policy brief No 12, 2011. http://tinyurl.com/ohukcsu