Adaptation to Climate Variability and Change in Semi-Arid Areas of Tanzania: A Case of Igunga and Kishapu Districts in Tanzania

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Abstract

In Sub-Saharan Africa (SSA), the impact climate change on agricultural activities has increased significantly and understanding how farmers adapt to it is vital in the implementation of appropriate policies to boost agriculture, which is the focus of this paper. The study sample size had 240 respondents from Igunga and Kishapu districts in Tabora and Shinyanga regions of Tanzania, respectively. Data collection methods included focus group discussions, key informant interviews and household surveys. Whereas qualitative data were subjected to content analysis, quantitative data were analysed using the multinomial logistic regression analysis approach. The study found that the strategies farmers in Igunga and Kishapu adopted in response to climate variability and change include altering planting dates, using of improved seed varieties, planting trees, applying industrial pesticides, using mixed cropping methods, growing drought-resilient crops, and using the ex-plough. The result of the multinomial logit analysis using Wald statistic values shows that education and household size had a significant effect on the dependent variable ($\beta = 1.068$, Wald = 2.541, $P \leq 0.046$, and $\beta = 0.305$, Wald =5.934, $P \leq 0.015$) respectively on the likelihood of planting early maturing crops relative to other factors. Thus, the paper recommends for the integration of climate change adaptation policies as a priority matter in all developmental agendas of the country.

***Keywords*:** Adaptation strategies, agriculture, livestock keeping, household, climate change and variability

1.0 INTRODUCTION

Tanzania is one of the Sub-Saharan African (SSA) countries in which agriculture is the backbone of the economy (URT 2010b). In fact, agriculture remains the largest sector in the economy and, hence, its performance has a significant effect on output and corresponding income as well as poverty levels. In statistical terms, Tanzania's agriculture is a major source of the country's food, accounts for about 45% of the GDP, 60% of merchandise

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exports, 75% of rural household income and 80% of employment (URT, 2013b). Furthermore, agriculture stimulates economic growth indirectly, through larger consumption linkages than other sectors have with the rest of the economy. In essence, higher and sustained agricultural growth are necessary to meet Tanzania's National Strategy for Growth and Reduction of Poverty (NSGRP, also called MKUKUTA in Kiswahili).

Although climate variability and change affect agricultural activities differently from one geographical location to another, what is clear is that these changes will bring about substantial welfare losses, especially for smallholders whose main source of livelihood derives from crop farming and livestock keeping (Kabote et al., 2013). As such, there is a need for nations to neutralise the potential adverse effects to avoid potential welfare losses to this vulnerable segment of the society.

Adaptation to climate change refers to adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities. In this regard, Füssel (2006) argues that high emphasis should be placed on adaptation mainly because human activities have already affected climate. In fact, climate variability and change continue based on the past trends; and the effect of emission reduction or mitigation takes several decades (ibid.). As such, adaptation can be undertaken at the local or national level as it is less dependent on the actions of others.

In truth, whereas climate variability is a global phenomenon, adaptation is largely site-specific (IPCC, 2007). Aside from its significance for adaptation and assessing long-term climate variability and current climate variability, traditional adaptation strategies also reflect the social organisation of the group facing these climatic changes. However, a common disadvantage for local coping strategies is that they are often not documented, but rather handed down through oral history and local expertise (Kattumuria et al. 2015). As site-specific issues require site-specific knowledge, experience shows that adaptation measures identified do not necessarily translate into changes because of context-specific social, financial, cultural, psychological and physiological barriers to adaptation (IPCC, 2014). It is important to understand clearly what is happening at the community level because farmers are the most climate-vulnerable group.

The consequences of climate variability vary depending on how a society has organised itself in relation to its resource base, its relations with other societies, and its relations with its institutions and the relations among its members (Yanda, 2013). In fact, inequality or social differentiation and marginalization are among critical determinants of adaptation (SUA, 2009). After all, different people groups and places within regions differ in their ability to adapt and divisions between the rich and the poor translate into differential sensitivity to climate variability or change (Kangalawe and Lyimo, 2013).

This paper attempts to delineate the adaptation strategies to current climate variability of smallholder farmers and livestock keepers in Igunga and Kishapu districts of Tabora and Shinyanga regions of Tanzania, respectively. Moreover, it assesses the suitability of these adaptation strategies in coping with climate threats. Finally, it discusses choices that can help enhance adaptation to climate variability in the long-term. The main basis for focusing on the current adaptation strategies to climate variability originates is the conclusion of IPCC (2014) to the effect that "a first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability" (Mongi et al., 2010). In the meantime, available strategies and actions can increase resilience across a range of possible future climates while helping to improve human health, livelihoods, socio-economic well-being, and environmental quality (Mongi, et al., 2010).

2.0 LITERATURE REVIEW

In Tanzania, agriculture and livestock are the most important sectors of the economy. Yet, these sectors have been hit the hardest by climate change. Indeed, this dire effect has been confirmed by several studies in Sub-Saharan Africa. Climate variability and change have reduced the length of growing seasons as well as made some areas of marginal agricultural potential out of production (IPCC, 2007).

Although climate variability affects the agricultural sectors of different countries in different ways, these changes generally bring about substantial welfare losses, especially for smallholders whose main source of livelihood are agriculture and livestock (Kabote et al., 2013). In fact, there is concern on marginal groups that are dependent on climate-sensitive resources but without means for adapting fast enough and are, thus, vulnerable to both current and future climate variability (Downing et al., 2005; Smit, 2001). Adaptation to climate variability is necessary both to reduce current vulnerability to climatic hazards and stresses as well as to prepare for future climate change (Kangalawe, 2012).

On the whole, the adaptive capacity determines the nature of adaptation strategies (Majule et al., 2008). In the climate variability and change context, effective adaptation strategies are those that reduce present vulnerability while reducing vulnerability to future climate change. Developing countries such as Tanzania often lack the necessary institutions or people to deal effectively with climate-related priorities (Bushesha et al., 2009; Gwambene, 2007). Yet social capital and efficient institutional networks are key to developing adaptive capacity in response to climate change and other stressors at all levels (Brooks et al., 2005; Pelling and High, 2005) Climate change adaptation rhetoric needs to be more closely linked to political ecology, sustainable development and development policy initiatives for win-win solutions at multiple scales to emerge (Munasinghe and Swart, 2005).

Climate-related interventions, therefore, need to be integrated into development planning and support poverty-alleviation and development initiatives that are ongoing buttressed by institutional support (Burton et al., 2002). This can help support the goals of addressing issues of equity and distribution of benefits in climate adaptation policy (Adger et al., 2006; Paavola et al., 2006, Thomas and Twyman, 2005). The emerging field of adaptation policy supports the need for involving targeted beneficiaries and understanding local vulnerability and adaptation to climate change (Huq et al., 2003; Lim et al., 2005). Some least developed countries (LDCs) have started to explore national priorities for adaptation and have developed national adaptation plans of action (NAPAs). However, a need still exists for further work on understanding the existing dynamics of adaptation before project initiation. This understanding should provide a basis for developing an adaptation policy to climate variability aimed to reduce vulnerability and human insecurity.

Some studies have pointed out several socio-economic, environmental factors, and the economic structure, as key drivers behind farmers' choice of specific methods of mitigation in Africa, as a whole, and in some specific SSA countries (Deresa et al., 2009; Kabubo-Mariara, 2008; Mideksa, 2009; Bryan et al., 2009). Thus, there is a need for each nation to understand the scope of climate variability and change and the drivers of adaptation (URT, 2010b), particularly amongst its small-scale farmers and pastoralists to craft appropriate policy responses, as the vulnerability and sensitivity of each area differs, as does the accessibility of the different adaptation methods (URT, 2013b).

3.0 MATERIALS AND METHODS

3.1 The Study Area

The study was conducted in Igunga and Kishapu districts (Figure 1) of Tabora and Shinyanga regions, respectively. Igunga district is found between latitudes 3^{o} and 4^{o} South and longitudes 34^{o} and 35^{o} East of meridian of Greenwich, and its altitude ranges between 1000 and 1500 metres above sea level (m.a.s.l). The mean annual rainfall is 400 mm – 750mm. Temperatures are high ranging between 20^{0}C to 33^{0}C. Kishapu district, on the other hand, is located between longitudes 36˚30' and 33˚30'E and latitudes3˚45' and 5˚00'S. The two districts were chosen based on their climatic condition. The mean annual rainfall in Kishapu is between 600 mm and 800 mm and surface temperature ranges between 16^{0}C in June and 30^{0}C in October with an altitude 1000-1200m above sea level. In both Igunga and Kishapu districts the rainfall regime is mainly unimodal and most of the people are agro-pastoralists as they depend on both crop production and livestock as their main economic activity for food and income. Moreover, both districts lie entirely in semi-arid areas and experience frequent droughts. In fact, climate variability and unpredictability have had a major impact on the people's livelihoods in either area.

In particular, the two districts were, indeed, selected based on their history of experiencing frequent drought, crop failure, hunger and history of receiving food aid, which have increasingly become common over the past twenty years. The study involved five villages including Bukama and Mbutu in Igunga district, Tabora region; and Mwamalasa, Kishapu and Masanga in Kishapu district, Shinyanga region (Figure. 3.1). These villages lie entirely in semi-arid agro-ecological zone in which rainfall is already uncertain.

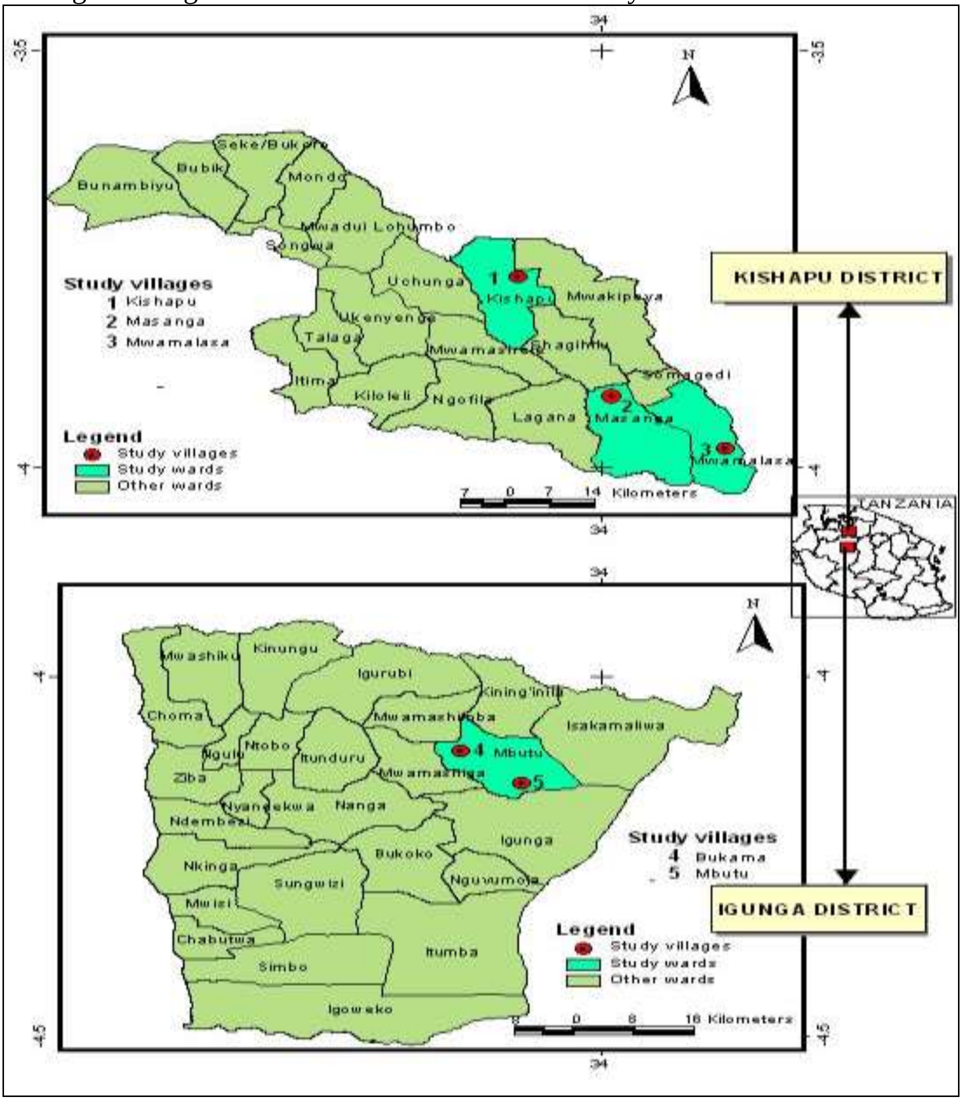

Figure 3.1: Map Showing Study Areas

3.2 Data Collection

The study adopted a cross-sectional research design. Household survey, focus group discussion (FGD) and key informants' interview were the main data collection techniques. These techniques enabled the collection of both qualitative and quantitative data. A structured questionnaire with closed-ended questions was administered with 240 randomly selected respondents drawn from sample frame using systematic random sampling. The sample size was determined using the formula as presented by Kothari (2004). In each village, 48 farmers (heads of household) were surveyed. The main survey was preceded by pre-testing of the questionnaire, which occurred at Ziba village. This involved 15 respondents.

Focus group discussions (FGDs) ensured that the study struck a balance between farmers and agro-pastoralists, which is supported by Chambers (1994). The study held ten FGDs (see Table 1) in which a total of 95 participants participated. Each focus group involved 6 - 8 participants. These participants were aged from 29 - 70 years, an age range that allowed the study to capture diverse views from different age groups. In fact, there were separate groups for men and women to capture views from each gender. The study capitalised on a lesson learnt in Bukama that women could not speak freely when mixed with their men counterparts. As such, there was a need to have separate groups for men and women. A similar approach was also used by Simelton et al. (2013) and Gebreeyesus (2017). During discussions information was tape-recorded. Agriculture and livestock extension officers, as key informants, were selected purposively. Characteristics of the FGD participants are presented in Table 3.1.

Table 3.1: Characteristics of FGD Participants

Village Name	Number of FGDs conducted	Number of Male Participants	Number of Female Participants	Minimum Age (Years)	Maximum Age (Years)
Bukama	2	7	9	30	60
Mbutu	2	10	11	29	63
Mwamalasa	2	12	11	35	65
Kishapu	2	6	12	31	67
Masanga	2	12	5	32	70
Total	10	47	48	NA*	NA

* NA = Not Applicable

Key informant interviews are intended to collect qualitative, in-depth information (Kumar, 1987) from a wide range of people with first-hand knowledge of the study area. In this regard, a series of key informant interviews were conducted with the traditional community leadership local authorities, who provided insights on community management support rendered during droughts. These key informants with known experience and expertise in connection with the research topic were selected using Expert Sampling Technique, which is essentially a specific sub-case of purposive sampling.

3.3 Data Analysis

The analysis based on the statement of the problem, research objective and research questions from which conclusions and recommendations were drawn. The Statistical Package for Social Sciences (SPSS) version 19 was used for descriptive statistics. Means, percentages and frequencies were used to summarise and categorise the information gathered. The frequencies and percentages of each factor were determined using a 5-point Likert scale, whose score ranged from strongly agree (5), agree (4), not sure (3), disagree (2) to strongly disagree (1) (Churchill and Iacobucci, 2005). For Igunga with 119 respondents, the maximum possible score is 595 points (119 multiplied by 5) (see Table 2). The same procedure was used to obtain the scores for Kishapu with 121 participants whose maximum potential score was 605 (see Table 3).

The multinomial logit regression model was used to determine the factors influencing farmers to use a particular adaptation method to climate variability and change (Tazeze et al., 2012; Sani et al. 2014). In this model, the dependent variable was multinomial with as many categories as the number of climate change adaptation methods recorded in the study area.

The interpretation of the output from the model focused on β-coefficients for measuring the directions of the influence (positive or negative) of independent variables; Wald statistics for measuring the magnitudes of the influence; p-values for testing significance of the influence; and odds ratios (EXP(B) values) for predicting the number of times various predictor variables have chances relative to one another regarding the adoption of improved varieties and change of grazing arrangements (Kabote et al., 2013). The Multinomial logistic regression model used was as shown in equation (1).

Model specification,
The general form of multiple regression:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_k X_k + \mu \quad \text{...} (1)$$

Where, Y is the dependent variable, β_0 is Intercept, β_1 - β_k are coefficients of independent variables, X_1 - X_k are the independent variables and μ is the Error Term.

The model which captured factors that determine adaptation strategies was described as

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \mu \quad \text{...} (2)$$

Where:
Y= Adaptation strategies, β_0 = Constant/Intercept; β_1 to β_{11} Coefficient of Independent variables X_1 = Respondents' age, X_2 = Respondents' years of schooling, X_3 = Size of acreage, X_4 = Household size, X_5 = Location, X_6 = Gender of respondents, X_7 = Economic status, X_8 = Size of, X_9 = Occupation, X_{10} = respondents' age, X_{11} = respondents' years of schooling, X_{12} = household size and X_{13} = occupation.

4.0 RESULTS AND DISCUSSION

Across the study area both in Igunga and Kishapu districts a number of adaptation measures to climate change and variability were reported. Those one with a mean score of 50% and above include changing of planting dates; growing of more improved maize; cultivating fewer plots; growing of more drought resilient crops; and use of the oxen-driven plough. Practising mixed cropping and use of more industrial pesticides were reported with a mean score above 50% only in Kishapu district. Also, findings indicate that farming experience, education level and economic status of the respondent significantly affected the use of different methods of adaptation.

4.1 Adaptation Strategies Farmers Use to Cope with Climate Variability and Change

4.1.1 Changes in planting dates

The household's survey data presented in Tables 2 and 3 on adaptation strategies show that 72% and 90.7% of the responses of farmers who owned farms had changed their planting dates in Igunga and Kishapu districts, respectively. A similar finding was also reported by Smit and Skinner (2002) in their research on adaptation options in agriculture carried out in Canada. This change was attributable to the changing onset of rainfall and its intensity. It suggested a need to make appropriate arrangements for the planting calendar that could play a crucial role in climate change adaptation. Arrangement for appropriate planting calendar plays a crucial role in adapting to climate change, as also reported by Kabote *et al*. (2013).

One of the participants during focus group discussion held at Mwamalasa village in Kishapu district reported that *"Nowadays for a successful harvest, planting should be done with the immediate onset of the rain in November and December."* In addition, the participant explained that with variable rainfall concentrated within a short period of time, planting early when the soil was still wet helped crops to survive and tolerate drought conditions until further rains arrived. Another participant from Bukama village in Igunga district reported that: *"These days, the first rain is an indicator for the start of the season and many of us would start field preparation ready for planting at that time, while a few would sow their seeds to exploit early rains and benefit from the earlier harvest."*

Table 4.1: Adaptation Strategies by Igunga Farmers

Statement	Strongly agree	Agree	Not sure	Disagree	Strongly disagree	Score	Score as % of the max
You have changed planting dates now	33	66	0	2	0	433	72
You practice mixed cropping more than past decades	0	28	0	69	3	253	42
You grow more improved maize varieties now than past decades	5	92	3	0	0	402	66
You cultivate fewer plots now than in past decades	40	60	0	4	2	448	74
You grow more drought-resilient crops now than in past decades	5	92	3	0	0	402	66
You depend more on remittances now than in past decades	0	5	2	93	0	162	27
You cultivate more crops other than maize and beans now than in past decades	20	12	0	18	20	206	34
You depend more on non-farm activities now than in past decades	0	51	0	49	0	302	50
You keep more livestock now than in past decades	0	15	0	78	5	221	37
You use more industrial pesticides now than in past decades	0	33	0	66	2	266	44
You use more manure now	0	42	0	58	0	284	47
You use ex-plough more now	5	82	2	11	0	389	64
You use more factory fertilizer now	0	10	0	89	0	218	36
Note! *Strongly agree = 5; Agree = 4; Not sure = 3; Disagree = 2; strongly disagree = 1*							
n=119							
Maximum score=119 x 5= 595							

Source: Field Data (2018)

Table 4.2: Adaptation Strategies by Kishapu Farmers

Statement	Strongly agree	Agree	Not sure	Disagree	Strongly disagree	Score	Score as % of the max
You have changed planting dates now	57	42	2	0	0	549	90.7
You practice mixed cropping more than past decades	38	48	8	5	1	425	70.2
You grow more improved maize varieties now than past decades	32	64	3	2	0	429	70.9
You cultivate fewer plots now than in past decades	33	55	0	8	4	405	66.9
You grow more drought-resilient crops now than in past decades	30	65	2	3	0	422	69.8
You depend more on remittances now than in past decades	2	18	0	60	20	222	36.7
You cultivate more crops other than maize and beans now than in past decades	0	51	0	49	0	302	49.9
You depend more on non-farm activities now than in past decades	0	48	2	44	7	293	48.4
You keep more livestock now than in past decades	0	16	0	75	9	214	35.4
You use more industrial pesticides now than in past decades	13	55	2	28	2	349	57.7
You use more manure now	0	53	0	46	2	179	29.6
You use ex-plough more now	0	44	2	32	23	156	57.8
You use more factory fertilizer now	0	15	2	77	5	225	37.2
Note! *Strongly agree = 5; Agree = 4; Not sure = 3; Disagree = 2; strongly disagree = 1*							
N=121							
Maximum score=121x5=605							

Source: Field Data, 2018

Furthermore, participants during FGDs reported that early planting was no longer feasible due to irregular and unpredictable rainfall, as early planted maize dried and withered due to drought, whereas other plants were eaten by pests such as stalk borers. Similar results have also been reported by Mongi et al. (2010) in Uyui district in Tabora region, Tanzania; Mathugama and Peiris, (2011) in India; Moyo et al. (2012) and Kori et al. (2012 in semi-arid areas of Zimbabwe and South Africa, respectively. These results have negative impact on rain-fed agriculture and livestock production (Rowhani et al., 2011), especially in semi-arid areas (IPCC, 2007).

While; one FGD participant in Kishapu reported on staggering planting: *"The shortened growing season limits the staggering of planting dates and also has forced farmers to abandon their plots in Kishapu district"*. Staggered planting dates reduced the impacts of crop damage due to adverse weather events, the outbreak of crop diseases and insect pests. It minimised the chances of no harvest within the season because crops were planted at different times on separate plots. Similar results have also been reported by Whitmore (2000) in the Netherlands.

4.2 Mixed Cropping as an Agricultural Adaptation Strategy

Adaptation strategy to climate variability employed by the majority of the farmers in Kishapu and Igunga districts was mixed cropping. The measure scored higher in Kishapu district and lower in Igunga farmers who owned farm plots with 42% and 70.2%, respectively (see Tables 4.1 and 4.2). Farmers grew simultaneously selected varieties of crops on the same farm plot at different times, hence maximising production from the single farm plots. They ensured that the crops planted together did not compete with each other for physical space, nutrients, soil moisture and sunlight, but they grew together for mutual benefit. For instance, some crops provided shade, shield crops against wind effects and rainfall damage, and improve soil nutrients/fertility (compost mulches form foliage and nitrogen fixation plants), and hence they increased crop productivity by maximising the use of scarce resources.

As opposed to monoculture cropping, mixed cropping benefited rural farmers in various ways, for example, by balancing soil nutrients' input and output, lowering the rate of weed growth, minimising the damaging effect of insect pests and crop diseases and resisting climate extremes. Evidence gathered from farm-based FGDs at Masanga village in Kishapu district indicated that, mixed cropping techniques were influenced by individual household preferences for crops and the location made crop mixing vary from one farm plot to another. These observations were consistent with extant empirical literature on agro-forestry. Charles et al. (2013), for example, reported that inter-cropping helped to cushion smallholder farmers against environmental extremes by creating micro-climate conditions that provide shade and shelter for the crops in addition to acting as alternative sources for animal feeds during droughts.

4.3 Growing of Improved Crop Varieties as an Adaptation Strategy

During household interviews and FGDs, participants were asked about the types of crops they produced. The study results showed that different crops were grown in the two districts under review. These different crops are presented in Tables 4.3, 4.4 and 4.5. The respondents were also asked to indicate whether there are crops that had been abandoned. Respondents in Igunga indicated that they had abandoned beans and bulrush millet. In Kishapu district it was also reported that indigenous maize varieties have been abandoned in favour of new improved varieties. A similar observation was also reported by Kabote *et al.* (2013) in Iramba and Meatu also in Tanzania that some crops have been abandoned because of their sensitivity to and vulnerability during droughts. In fact, cultivation of drought and pest-resistant crops varieties was one of the local adaptation strategies to the impacts of climate variability and change, especially those associated with unreliable and unpredictable rains.

However, the household survey data presented in Tables 4.1 and 4.2 clearly show that 66% and 70.9% of the households in Igunga and Kishapu districts, respectively, adopted improved crop varieties that could be harvested within a short growing time.

Table 4.3: Sorghum Varieties

District Name	Sorghum variety	Percentage
Kishapu	Masia	90.9
	Serena	9.1
	Total	100
Igunga	Masia	81.3
	Serena	18.8
	Total	100

Source: Field Data, (2018)

Notably, as Table 6 illustrates, the adoption of improved crop varieties was higher for maize and cotton relative to other crops in the study areas. During interviews, four crops were reported to be cultivated by farmers in the study area. Cotton was most cultivated as a cash crop in both districts, followed by maize. However, as Table 5 indicates, about 37%, 25%, 21% in Kishapu and 36%, 37%, 16% and 11% in Igunga reported growing improved crop varieties of cotton, maize and sunflower, respectively.

Table 4.4: Improved Crop Varieties Grown in the Study Areas

District	Name of improved crop variety	Responses	
		Count	Percentage
Kishapu	Maize	19	25.30
	Sunflower	16	21.30
	Sorghum	12	16.00
	Cotton (UKM8)	28	37.30
	Total	75	100.00
Igunga	Maize	58	36.90
	Sunflower	25	15.90
	Sorghum	17	10.80
	Cotton (UKM8)	57	36.30
	Total	157	100.00

Source: Field Data (2018)

Household interviews and FGDs also reported some of the crop varieties including maize varieties to be currently grown in the study areas.

Table 4.5: Improved Crop Variety Used

District Name	Improved crop variety used	Responses	
		count	Percentage
Kishapu	Maize	19	25.30
	Sunflower	16	21.30
	Sorghum	12	16.00
	Cotton (UKM8)	28	37.30
	Total	75	100.00
Igunga	Maize	58	36.90
	Sunflower	25	15.90
	Sorghum	17	10.80
	Cotton (UKM8)	57	36.30
	Total	157	100.00

Source: Field Data (2018)

The District Agricultural and Livestock Officer (DALDO) said during an interview that in terms of performance, hybrid crop varieties had higher yields; performed well under low rainfall conditions, tolerated drought and mature early, thus made them ideal for growing in the study areas. The cultivation of different improved crop varieties was also recommended by other researchers as appropriate in adapting to current changes in climate and weather variability (IPCC, 2007). During FGDs, farmers reported a preference for growing a maize seed variety such as *Pannar* and explained that the variety had higher yields, and it took a shorter time to mature. The participant mentioned another type of maize variety called *Stuka* confirming. Although it had good yields under good weather conditions and had bigger maize corn as compared with *Pannar*, it was not suitable for roasting.

A respondent from Mwamalasa in Kishapu district reported that, the planting of maize varieties, which stay under moisture stress conditions, has increased maize harvests compared with harvests from local maize varieties under tough weather conditions. Moreover, during FGDs held both in Igunga and Kishapu districts, it emerged that shortened growing periods caused by short rains season resulted in failing of most of the indigenous maize varieties. Thus, growing improved new crop varieties assured farmers of a bigger harvest than when they planted the local varieties.

4.3 Cultivating fewer Plots Couples with Mixed Cropping

In both districts, coping strategies employed to deal with climate variability and change conditions entailed reducing the size and number of plots tilled in a given season. The statement on the number of plots cultivated scored among all groups with 74% and 66.9% of the overall maximum scores in Igunga and Kishapu, respectively (see tables 4.1 and 4.2). The study found that farmers cultivated smaller farm plots, but maximized plot use by planting different crops on the same lot simultaneously, which increased the chances of reaping more than otherwise possible. By reducing the size and number of plots cultivated, the household effectively invests resources and energy on a small area, hence they ensured effective land use that could otherwise not be utilised under mono-culture system. During the FGD held at Bukama village, Igunga district, one of the participants said:

> "*…these days most of the farmers engage in cultivating fewer and smaller sizes of farm lots because the moment one finishes weeding on one farm, the soil is already dry. Hence working on another farm plot increased soil moisture loss, which affected crop growth and led to crop wilting and drying up…"*

Indeed, the majority of the respondents in the focus group discussions reported reducing the size and number of plots due to droughts and rainfall uncertainties, which affected crop growth and yields. The group discussions confirmed that some farmers risked and cultivated larger farm areas hoping that favourable conditions could make them harvest enough for the family use and a surplus for the market.

4.4 Application of Pesticides as a Coping Strategy

During household survey in both districts, the respondents indicated an increase in incidences of crop pests as tables 4.1 and 4.2 illustrate. In Kishapu district, for instance, the most serious pests reported were cotton boll-worms, Stalk borers, cotton strainers and birds. During the FGDs, it was also reported that, bulrush millet had disappeared in Mwamalasa and Masanga villages due to bird infestation. In Igunga district, the crop pests of major concern similarly include Cotton boll-worm, stalk borers, pests and diseases (see Table 4.6). In fact, these also were among major causes of low productivity in crops and livestock worldwide and, particularly, in sub-Saharan Africa where there are few resources to invest in pesticides for plants and vaccines for livestock (Williamson et al., 2008). During in-depth interviews and FGDs, it emerged that, drought has increased pests and diseases for almost all crops except for local sweet potatoes in the study area (see Tables 2 and 3), despite the majority reported using more pesticides then than in the past. Indeed, about 57.7% and 44% of respondents in Kishapu and Igunga, respectively, reported applying agricultural pesticides.

Table 4.6: Incidences of Pests and Diseases in Igunga and Kishapu

	Kishapu		Igunga	
Name of pest/disease	**Freq.**	**%**	**Freq.**	**%**
Boll-worm	28	100	18	84
Stalk borer	24	96	16	67
Cotton strainers	23	94	7	28
Birds (Quelea quelea)	25	98	5	20
Aphids	14	58	3	14
Shootfly	16	64	4	16
Leaf spot	8	32	11	44
Smut	5	20	7	28

Source: Field Data (2018)

4.5 Modeling Farmers' Adaptation Strategies to Climate Variability and Change

Farmers' characteristics relate to adaptive capacity in the adaptation process derived from a vast body of research on the dynamics of agricultural development and diffusion of agricultural practices. The review of empirical literature on adoption of new technologies and adaptation revealed that many studies hypothesise that a range of households and farm characteristics that describe local conditions influence farmers' adaptation strategies, as was the case in Igunga and Kishapu districts. The analysis of multinomial logical regression to determine the factors influencing the farmers to use a particular method of adaptation to climate change reveal that farming experience, educational level and economic status significantly affected the use of different methods of adaptation, as Tables 4.7 and 4.8 illustrate.

Table 4.7: Adaptation Strategies Farmers Mostly Use

Adaptation Strategies*	**Frequency**	**Percentage**
Planting drought-resistant crops	97	40.4
Planting early maturing crops	67	27.9
Use of pesticides to control pests	25	10.4
Tree planting	51	21.3
TOTAL	240	100

*The reference category is planting drought resistant crops

Source: Field Data (2018)

Quantitative results in Table 4.7 show that, out of eight variables entered in the model, education and household size increased the probability of uptake of planting early maturing crops by 0.05% whereas farmer's age increased the probability of planting maturing crops by 0.01%. The rest variables were not significant at the 5% level of significance. The empirical results of the adaptation model coupled with the positive sign on ß-coefficients implies that such variables increased the respondents' likelihood to plant early maturing crops as opposed to the negative sign. Using Wald statistic values, the results show that education and household size had a significant effect on the dependent variable (ß = 1.068, Wald = 2.541, $P \leq 0.046$, ß= 0.305, Wald =5. 934, $P \leq 0.015$), respectively, on the likelihood of planting early maturing crops relative to other factors. This outcome is congruent with the results of Assoumana et al. (2016) and Tazeze et.al. (2012). Remarkably, this can be explained by literate farmers being unable to search for information and act based on their preferences and level of information gathered. The results also show that the odds ratio for was 1.07. The implication is that an increase in one more year of education increases the probability of farmers using early maturing crops as opposed to not undertaking any adaptation measures. However, farmers with more years of practice in farming under their belt increase the probability of uptake of all adaptation options because their experience made them have better information and knowledge on changes in climatic conditions and crop and livestock management practice than novice farmers. This was also reported by Nhemachena and Hassan (2007) in their study in South Africa.

Table 4.8: Results of the Logistic Regression on Likelihood of Smallholder Farmer Planting Early Maturing Crops (N=240)

Variables entered in the model	ß	S. E	Wald	Significance	Exp(B)
Respondents' age	0.088	0.034	6.771	0.009	1.092
Years of schooling	1.068	0.192	2.541	0.046	1.07
Size of acreage	-0.021	0.024	0.734	0.391	0.98
Household size	0.305	0.125	5.934	0.015	1.356
Location	-0.041	0.56	0.005	0.941	0.96
Gender of respondents	-0.526	0.724	0.527	0.468	0.591
Economic status	0.754	0.61	1.528	0.216	2.126
Size of livestock	0.573	0.719	0.635	0.426	2.126

Source: Field Data (2018)

The results presented in Table 4.8 show that the probability of planting trees as an adaptation strategy can be influenced by household size and economic status. Unlike the hypothesis ($P > 0.05$), the study results show that the household size and economic status increased planting trees and were significant at 5% whereas farmers' age increased planting trees were significant at 1%.The empirical results of the adaptation model, using Wald statistic values the results reveal that household size had significant influence (ß = 0.303, Wald = 6.337, $P < 0.012$). Furthermore, household size as a proxy indicator to labour availability, may affect the uptake of a new technology positively as its availability reduces the labour force constraints. The results also indicate that economic status (wealth) can influence of tree planting as an adaptation strategy. Unlike the hypothesis (P > 0.05), the results reveal that the economic status had significant influence ((ß = 1.558, Wald = 5.19, P < 0.013), then households' size with high economic status are in better position to adopt planting trees as an adaptation strategy. This is confirmed by Sani et al. (2016) who reported that large-scale farmers are more likely to adapt to climate change because they have more capital and resources than small-scale growers.

Table 4.9: Results of the Logistic Regression on the Likelihood of Smallholder Farmers Planting Trees (n=240)

Variables entered in the model	ß	S.E	Wald	Significance	Exp(B)
Respondents' age	0.007	0.035	0.044	0.833	1.007
Years of schooling	-0.076	0.095	0.631	0.427	0.927
Size of acreage	-0.055	0.039	1.956	0.162	0.946
Household size	0.303	0.12	6.337	0.012	1.354
Location	0.44	0.649	0.46	0.498	1.553
Gender of respondents	0.476	0.67	0.505	0.477	1.609
Economic status	1.558	0.684	5.19	0.013	4.751
Size of livestock	0.45	0.779	0.334	0.563	1.568

Source: Field Data (2018)

Using Wald statistic values the results from Table 4.9 reveal that the age of household had significant influence (ß = 0.074, Wald = 1.977, P < 0.058). The probability of smallholder farmers of using pesticides to control pests and diseases increases in relation to the age of the household and it was significant at 10%. As the age of the household increases, the likelihood of the smallholder farmers to use pesticides to control pests and diseases in their crops and livestock increases. Hence the hypothesis on the effect of age of the household is positively related to smallholder farmers' use pesticides in order to control pests and diseases. The rest variables were not significant at the 5% level of significance.

Table 4.10: Results of the Logistic Regression on the Likelihood of Smallholder Farmers' Use of Pesticides to Control Pests and Diseases (n=240)

Variables entered in the model	ß	S. E	Wald	Significance	Exp(B)
Respondents' age	0.074	0.053	1.977	0.058	1.077
Years of schooling	0.25	0.188	1.767	0.16	1.284
Size of acreage	-0.068	0.056	1.464	0.184	0.934
Household size	0.184	0.194	0.897	0.226	1.202
Location	0.267	0.886	0.091	0.344	1.306
Gender of respondents	-0.526	0.724	0.527	0.468	0.269
Economic status	0.754	0.61	1.528	0.126	0.819
Size of livestock	0.573	0.719	0.635	0.426	2.126

Source: Field Data (2018)

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the main objective of this study, it is apparent that farmers in the study area have adopted different adaptation strategies to deal with climate change. The main adaptation strategies of farmers identified in this study include "Change of planting date," "Use of improved varieties", "Planting trees", "Use of industrial pesticides", "Use of mixed cropping", "Growing drought-resilient crops" and "Use of oxen-driven ploughs." Several factors such as the age of the household (farming experience), educational level, farm size and economic status determine the influence of adaptation strategy.

These findings have implications for public policy, hence calling on governments to include climate change adaptation policies in their development agenda. Moreover, the study findings should help policy-makers to better think and plan for agricultural policies in terms of adaptation to climate variability and change. Some agricultural policies may exacerbate the impact of climate change, while others may be effective in increasing and securing farmers' incomes.

Several adaptation strategies are initiated at community level on an ad hoc basis under restricted planning. Such strategies could lead to long-term sustainability if enhanced and well-planned. The diversity of the reported adaptation strategies indicates, however, that no single adaptation strategy may be sufficient for communities to adapt fully to climate variability and change. Thus, the complementarities attached to the diverse sets of adaptation strategies are crucial for the rural communities. Nevertheless, there a need for more information, education and a communication strategy on climate change issues affecting rural community livelihoods.

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