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# Socio-economic determinants of farmers' adaptations to climate change variability in Meatu and Iramba districts, Tanzania

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**Abstract**
The capacity of farmers to adapt to climate shocks and stresses is a critical part of sustainable development. Generally, farmers' adaptation to climate change variability exploits beneficial opportunities to reduce its vulnerability and minimize the risk associated with the impacts of climate change variability. As such, the aim of this study was to determine the socio-economic determinants of farmers' adaptation to climate change variability in Meatu and Iramba Districts, Tanzania. Specifically, the study was intended to determine farmers' adaptation to climate change variability in the study area, to compare households' adaptations for the two districts and to determine socio-economic factors influencing farmers' adaptation to climate change variability. A cross sectional research design was used for the study, whereby data were collected through a questionnaire distributed to 183 farmers and focus group discussions. Statistical Package for Social Sciences (SPSS) was used for data analysis. Descriptive and inferential statistics were used in the analysis of data. Results showed that majority of farmers' households had very low adaptation to climate change variability. Moreover, it was found that there was a significant difference on levels of farmers' adaptation between the districts ($\chi^2$=77.522, df = 3, p<0.0001), in which farmers from Meatu district had very low adaptation compared to those from Iramba district. It was also found that farmers' adaptation was significantly determined by sex, type of farming practiced by household's head, distance from home to the farm, distance from home to the market, distance to the sources of water and possession of entrepreneurial skills. The study concludes that farmers' adaptation to climate change variability mainly depends on the sex of head of household, distance from home to the farm, distance from home to market, distance to the source of water and possession of entrepreneurial skills. The study recommends increasing households' adaptation capacity to climate change variability through constructing sources of water and market near the villages; and empowering of farmers with knowledge and entrepreneurial skills which will enable them to create opportunities on non-farm activities.

**Keywords:** Adaptation; adaptation index; Meatu; Iramba; farmers; climate change variability

## 1. Introduction

### 1.1 Background Information

Tanzania, like all the countries in Africa, is highly vulnerable to the impacts of climate change (IPCC, 2007, URT, 2012). Climate change poses a great threat to human security through erratic rainfall. The extent to which the impact of climate change is felt depends largely on the extent of farmers' adaptation (Daulagala *et al.*, 2014) [3]. Generally, due to dependence of food on agriculture, external factors such as technological development have been used to adapting to changing conditions. Some of these responses include subsistence activities, while others include acute responses, used only in case of critical weather conditions (Scott and Kettleborough, 2002) [4].

Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects. Generally, the adaptation moderate harm or exploit beneficial opportunities (IPCC, 2007) [1]. Aadaptation also refers to all adjustments in behaviour or the economic structure that reduce the vulnerability of society to changes in the climate system including its current variability and extreme events as well as longer-term climate change (Smit *et al*., 2000) [5]. Adaptation to climate change is the degree to which adjustments in practices, processes, or structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change in climate (IPCC 2001) [6].

Common adaptation methods in agriculture include the use of new crop varieties and livestock species that are more suited to drier conditions, irrigation, crop diversification, mixed crop-livestock farming systems, change of planting dates and diversification from farm to non-farm activities (Bradshaw *et al*., 2004; Kurukulasuriya and Mendelsohn, 2006) [7, 8]. Others are, increased use of soil and water conservation techniques, changed use of capital and labour, and trees planted for shade and shelter (Maddison, 2006; Nhemachena and Hassan, 2007) [9, 10].
Adaptation in agriculture is expected to help farming household to achieve household food, income and livelihood security in the face of the changing climatic and socio-economic conditions which include climatic variability, extreme weather conditions such as droughts, floods and volatile short term changes in local and large-scale markets (Kandlinkar and Risbey, 2000) [11]. Normally, adaptation moderates vulnerability to climate change and helps farmers guard against losses due to increasing temperatures and decreasing precipitation (Spittle house and Stewart, 2003; Hassan and Nemachena, 2008) [12, 13]. Climate change adaptation in rural farming is location specific and required local-level analysis to gain a better understanding of the fundamental processes underlying adaptation and for better targeting of adaptation policies by national and local governments (Below *et al.,* 2012) [14]. In addition, a better understanding of processes that shape farmers' adaptation to climate change is critical in order to identify vulnerable entities and to developing well-targeted adaptation policies.
According to Bryan *et al*., (2009) [15], factors influencing adaptation include the socio-economic factors such as wealth, access to market, climate information, and access to fertile land. Generally, farmers are more likely to adapt, if they have information on climate change. Socio-economic factors have also been found to facilitate adaptation among the poorest farmers. For istance, the study by Evans *et al.,* (2011) [16] found that education of the farmers was an important determinant of adaptation to climatic changes by the dairy farmers.
Despite the above mentioned facts little empirical evidence exists in relation to what determines farmers' individual adaptation in the semi-arid area of Tanzania and beyond. Therefore, understanding the determinants of a household's decision to adapt a particular practice among the available choices may provide insights into the factors that enable or constrain adaptation. Hence, understanding household adaptation to climate change is important in the design and implementation of effective adaptation measures. As such, the general objective of this paper was to determine the socio-economic determinants of farmers' adaptation to climate change vulnerability at the household level using Iramba and Meatu district as case studies. Specifically, the paper was intended to (i) to determine farmers' adaptation in the study area (ii) to compare households' adaptation to climate change variability between the two districts and (iii) to determine socio-economic factors affecting farmers' adaptation to climate change variability.

## 1.2 Theoretical and Conceptual Framework
### 1.2.1 Theoretical framework
Two paradigms were used to explain the determinants and behaviour of farmers when adopting a new agricultural technology. These are innovation-diffusion model and adoption perception model. The Innovation-diffusion model by Rogers (1962) [17] proposes that innovation decision is made through a cost benefit analysis by the farmers. Farmers will only adopt an innovation when they believe that all things being equal, it enhances their utility. Thus, they must be convinced that the innovation yields some advantage to the idea it supersedes. In considering costs brought about by the innovation, they take into account how the innovation disrupts the day to day functioning facets of life. In addition, farmers consider an innovation with its compatibility with their daily habits and its user friendliness. Each innovation, decision is largely influenced by personal traits; hence the rate of adopting new innovations differs between farmers.
According to the Adoption perception model (Wossink *et al*., 1997) [18], farmers are assumed to hold specific perceptions regarding the effects of an innovation, and these subjective evaluations can significantly influence their adoption decisions. Thus, once the farmers are exposed to a new technology, they seek information about the attributes of this technology before its adoption. Furthermore, farmers go through a stage of being aware or acquire knowledge about a new technology to forming a positive or negative perception towards the technology and ultimately deciding whether or not to adopt the same (Sarker *et al.,* 2008) [19]. Therefore, adoption of a technology is influenced by a range of factors which include socioeconomic, such as age, sex and income) but also community factors (access to water sources, market).

### 1.2.2 Conceptual Framework of the Study
In the analysis of determinant of farmers' adoption of a new agricultural technology for climate change adaptation, it clearly appears that the socio economic factors are closely linked to the use of the technology (Rogers, 1962; Wossink *et al*., 1997) [17, 18]. This study therefore sought to investigate socio-economic determinants of farmers' adaptations to climate change. The study has built a foundation on "structuration theory" the focus of the theory is the development of relationship over time between structure and interaction. The relationship between independent and dependent variables of the study is as illustrated in the farmers' adaptation to climate change conceptual framework in Fig.1.

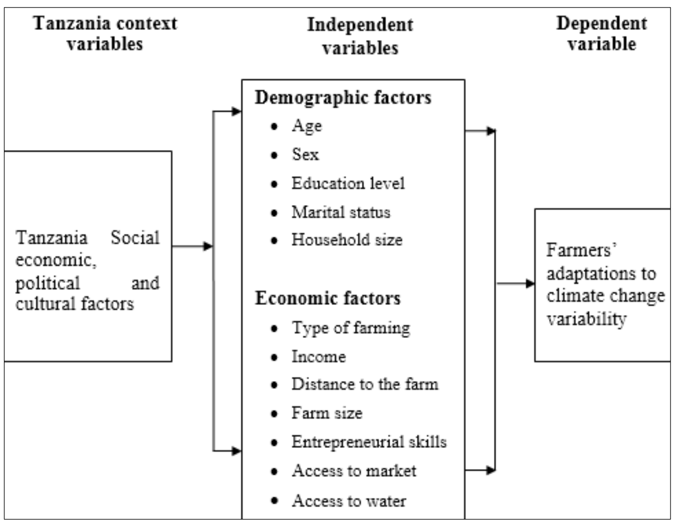


**Fig 1:** Conceptual framework of farmers' adaptation to climate change variability

## 2. Methodology

### 2.1 Study Area

The study was conducted in Iramba and Meatu Districts in Tanzania. Study areas were selected based on their significant levels of climate change variability. According to Tanzania 2012 census, the population of Iramba was 405 132 while that of Meatu was 405 177 (NBS, 2012) [20]. Meatu District is one of the five districts of the Shimiyu Region, Tanzania. The district covers 8 871 Sq. km and the altitude of between 1 000 and 1 500 m above sea level, with detached hills and grassy savannah woodlands. Meatu is divided into three agro-ecological zones based on annual rainfall, namely Northern zone, central zone and Sothern zone. The dry season begins in May after the harvest and lasts until November /December. Rains normally fall between November/December and April; light rains season in November to December and heavy rains which begin in December -February and decrease in intensity until April (URT, 1996) [21].

Iramba is one of the districts in Singida Region, Tanzania. The district is semi-arid with seven to eight months of dry season, lasting from late April to early November. The mean annual rainfall ranges from 600mm to 800mm and the rainfall is erratic and unreliable in terms of both amount and timing (URT, 2005) [22]. Generally, the district experiences two minor seasonal rainfall peaks in December and March to April (Otysina and Asenga, 1993) [23]. Precipitation, which occurs in brief storms, is lost through quick surface runoff and high evapotranspiration rates. Dry-season precipitation extends between May and November with less than 50mm per year, whereas, monthly evaporation rate exceeds the monthly rainfall almost every month (Ministry of Tourism, Natural Resources and Environment, 1995) [24].

### 2.2 Research Design

A cross-sectional research design was used to collect data to enable socio-economic determination of farmers' adaptation to climate change variability. The above design allows data to be collected at a single point in time (Levin, 2006) [25]. The design can also be used in descriptive studies and determination of relationships between variables (Varkevisser *et al*., 2003) [26]. The design was considered favourable to the nature of this study. Allinovi (2008) [27] argues that despite the weakness of being static/snapshot, cross sectional design can still be used for climate change adaptation and resilience studies.

### 2.3 Sampling Procedure and Sample Size

Multistage sampling was adopted for this study, whereby, purposive sampling was used to select the regions, districts, wards and villages and random sampling was used to obtain sample households. The household was used as the unit for analysis for this study. Iramba and Meatu Districts was purposely selected. These study sites were selected purposively to cover areas which frequently experienced crop failure due to climate change and have received food aid from the government (Kabote *et al.,* 2013) [28]. The criterion for inclusion in the sample was participation in farming and pastoralism.

The sample was drawn from two districts namely, Iramba district and Meatu district. One village was selected from Iramba district, namely Kidaru village and two villages, namely Mwashata and Mwamanimba were chosen from Meatu district. Only one Kidaru village was selected in Iramba because it was the only one having weather closely related to other two (Mwashata and Mwamanimba) villages. Fifteen percent (15%) of the total number of households in each village was used to determine the sample size. Saunders *et al.,* (2007) [29] suggest that a sub sample of 30 respondents is a bare minimum for studies which statistical data analysis is to be done regardless of population. Thus, 183 households were randomly drawn from the population from the three villages to form the sample size.

### 2.4 Data Collection Approaches and Methods

The study employed both qualitative and quantitative research approaches to investigate farmers' adaptation to climate change variability. The methods used to collect data were survey and focus group discussions (FGDs). Two FGDs were carried out in each village. This is also a way of ensuring that quality data is collected.

### 2.5 Measuring Farmers' Adaptation

In this study adaptation practices adopted by the farmers for a long period were used to provide the measurements for farmers' adaptation, which was expressed into adaptation index. As such, farmers' adaptation index was computed using the formula by Below *et al.,* (2012) [14]:

Adaptation index j = $w_1 p_1 j + \ldots + w_n p_n j$

Where $w_1$ = weighting factor of adaptation practice 1 (from PCA), $p_1j$ = jth household's value for practice 1 (value of 0 or 1, 1 if the farmer adopt and o if did not adopt the adaptation practice).

The adaptation index values ranged from -6 to 11. They were further categorized into five categories of adaptation as adopted from Lal (2014) [30], namely very low farmers' adaptation, low farmers' adaptation, moderate, high farmers' adaptation and very high farmers' adaptation whereby Less than -5 reflected very low farmers' adaptation, -4 to -3 low farmers' adaptation, -2 to 2 moderate, 3 to 3 high farmers' adaptation and more than 4 very high farmers' adaptation.

### 2.6 Data Processing and Analysis

Quantitative data were coded and analyzed using statistical package for social science (SPSS).The descriptive statistics, such as frequencies and percentages were calculated. Chi-square was used to determine relationship of the variables. To analyse the socio-economic determinants of farmers' adaptation to climate change variability, a multiple linear regression analysis was conducted. The basic assumption was that farmers' adaptation depends linearly on their socio-economic households' characteristics. The model is shown below:

$$Y_j = \alpha + a_1x_1 + a_2x_2 \ldots\ldots\ldots\ldots + a_{12}x_{12j}$$

Where, Yj is the household adaptation index. The $X_{ij}$ are the explanatory variables for farmers' adaptation to climate change ($x_1$=Age, $x_2$=sex, $x_3$=level of education, $x_4$=marital status, $x_5$=number of household members, $x_6$=type of farming,$x_7$=distance to farm, $x_9$=farm size, $x_{10}$=annual income, $x_{11}$=distance to water sources, $x_{12}$=entrepreneur skills) while a is the coefficient of the explanatory variables and α is the constant.

## 3. Results and Discussion

Before running the regression model, the collinearity/multicollinearity diagnostics test was done in order to detect whether there is a correlation among the independent ($X_i$) variables. Results in Table 1 showed that there were no variables that had tolerance value of <0.10 or VIF <10. This observation confirms that there was no violation of the multicollinearity assumption in this study.

**Table 1:** Results for VIF on the Determinant of Farmers' Adaptation to Climate Change Variability (n=183)

| Variables | Collinearity Statistics | |
|---|---|---|
| | Tolerance | VIF |
| Age of respondent | 0.877 | 1.140 |
| Sex of respondent | 0.866 | 1.155 |
| Level of education | 0.878 | 1.139 |
| Marital status | 0.860 | 1.163 |
| Number of household members | 0.885 | 1.130 |
| Type of farming | 0.828 | 1.208 |
| Distance to the farm | 0.592 | 1.690 |
| Distance to the market | 0.386 | 2.589 |
| Farm size | 0.865 | 1.156 |
| Annual income | 0.858 | 1.165 |
| Distance to source of water | 0.387 | 2.586 |
| Entrepreneurial skills | 0.706 | 1.417 |

According to According to Pallant (2011) [31], the multicollinearity problem is described by the presence of linear or near linear relationship among explanatory variables. Testing of the model on multicollinearity was done by using tolerance and Variance Inflation Factor (VIF) test which builds in regression of each independent variable. Pallant (2011) [31] suggests that a tolerance value less than 0.10 and a VIF above 10 indicate multicollinearity.

In addition, the Durbin-Watson's d tests was used to test for autocorrelations. The results showed that the Durbin-Watson's is 1.79 which falls within the rule of thumb values of $1.5 < d < 2.5$ (implying that there is no auto-correlation) (Kutner *et al.*, 2005) [32]. Hence, there is no auto-correlation in the multiple linear regression data.

### 3.1 Socio-economic Characteristics of Respondents

An overview of socio-economic characteristics of respondents is presented in Table 2. The researcher felt that it was necessary to get the background information of respondents because it can influence household adaptation to climate change. The background information included the socio-economic characteristics of respondents such as sex, age, marital status, educational level, farm size and household size.

About 64% of the respondents were males; while 35.5% of them were females meaning that majority of the households had been headed by males. As the sample was randomly drawn, it may be seen that male form the majority of the household head in the study area. However, there was no significant different on sex of the head household distribution among the two district ($\chi^2$=1.815, df=1, p=0.178). The high variation in marital status could also have some implications with respect to climate change adaptation. Previous study has found who found that female headed households have a lower adaptation scoring than their male counterparts (that Cassidy and Barnes, 2012) [33]. Also, FAO (2011) [34] mentions socially embedded inequalities as an influence towards the degree to which female farmers are affected by climate change variability.

**Table 2:** Socio-economic Characteristics of Respondents (n=183)

| Variable | | Iramba(n=67) | | Meatu(n=116) | | Total | | $\chi^2$ | df | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | f | % | f | % | f | % | | | |
| Sex | Male | 39 | 58.2 | 79 | 68.1 | 118 | 64.5 | 1.815 | 1 | 0.178 |
| | Female | 28 | 41.8 | 37 | 31.9 | 65 | 35.5 | | | |
| Age | 31 – 40 | 13 | 19.4 | 39 | 33.6 | 52 | 28.4 | 4.987 | 4 | 0.289 |
| | 41 – 50 | 24 | 35.8 | 39 | 33.6 | 63 | 34.4 | | | |
| | 51 – 60 | 14 | 20.9 | 20 | 17.2 | 34 | 18.6 | | | |
| | 61 – 70 | 9 | 13.4 | 10 | 8.6 | 19 | 10.4 | | | |
| | Above 70 | 7 | 10.4 | 8 | 6.9 | 15 | 8.2 | | | |
| Marital status | Unmarried | 6 | 9.0 | 11 | 9.5 | 17 | 9.3 | 1.376 | 3 | 0.711 |
| | Married | 57 | 85.1 | 99 | 85.3 | 156 | 85.2 | | | |
| | Divorced | 2 | 3.0 | 5 | 4.3 | 7 | 3.8 | | | |
| | Widower | 2 | 3.0 | 1 | 0.9 | 3 | 1.6 | | | |
| Education level | No formal education | 0 | 0.0 | 19 | 16.4 | 19 | 10.4 | 17.287 | 4 | 0.002 |
| | Primary education | 61 | 91.0 | 87 | 75.0 | 148 | 80.9 | | | |
| | Secondary education | 2 | 3.0 | 8 | 6.9 | 10 | 5.5 | | | |
| | Post-secondary education | 2 | 3.0 | 2 | 1.7 | 6 | 3.3 | | | |
| Farm size (areas) | 1 – 2 | 46 | 68.7 | 65 | 56.0 | 111 | 60.7 | 5.235 | 2 | 0.073 |
| | 3 – 4 | 0 | 0.0 | 6 | 5.2 | 6 | 3.3 | | | |
| | More than 4 | 21 | 31.3 | 45 | 38.8 | 66 | 36.1 | | | |
| Household size | 1 -2 | 12 | 17.9 | 41 | 35.3 | 53 | 29.0 | 6.936 | 2 | 0.031 |
| | 3 – 4 | 24 | 35.8 | 38 | 32.8 | 62 | 33.9 | | | |
| | More than 5 | 31 | 46.3 | 37 | 31.9 | 68 | 37.2 | | | |

The ages of respondents ranged from 31 to 76 years with majority aged from 41 to 60 years. This implies that people at the age between 40 and 60 years are more involved in farming. These findings suggest that respondents in a study area were more actively involved on entrepreneurial activities at the age between 31 years and above. However, there was no significant different on age distribution among the two district ($\chi^2$=4.987, df=4, p=0.289). The majority (85.2%) of the farmers were married, while 9.3% of them were unmarried. This indicates that there are more married individual farmers in Meatu and Iramba, these have responsibility and are expected to meet the needs of their families. However, there was no significant different on distribution of marital status among the two district ($\chi^2$=1.376, df=3, p=0.711). The distribution of marital status confirms that farming activities in the study area attract mostly adults, whose main activity for their wellbeing is farming. The high variation in marital status could also have some implications with respect to the household adaptation to climate change, due to the reason that the researcher found that marriage is an institution that has a great influence on family matters (Mdoe and Macha, 2002) [35].

It was also found that majority (80.9%) of respondents had primary school education. The finding that the majority of respondents had primary education is not surprising because primary education is a basic education in Tanzania; it is also regarded as basic right for every citizen (Mtahabwa, 2010; Sebates *et al.*, 2012) [36, 37]. Moreover the results revealed that was significant different on distribution of education among the two districts ($\chi^2$=17.287, df=3, p=0.002). For example there was no respondents without formal education in Iramba as compared with 16.4% of the respondents with no formal education from Meatu District. However, possession of the universal tools of basic education (writing, arithmetic and reading) does not necessary imply respondents' capability to adapt to climate change.

Results in Table 2 further showed that 60.7% of the farmers own less than 3 acres (< 1 hectare), while only 36.1% of all respondents own more than 4 acres of land. This implies that majority of the farmers are small scale farmers who do not have enough land to cultivate on and produce food for both human and livestock consumption. However, there was no significant different on land ownership among the two districts ($\chi^2$=5.235, df=2, p=0.073). Similarly, Jena (2012) [38] found that land ownership was linked to adaptation among farmers; it was found that famers who own large land have high adaptation to climate change than those who own small land. Table 2 also shows that more than one third of the farmers (37.2%) maintain a family (household) of more than 5 people, 29.0% have 1 to 2 household members. The implication for the household size of more than 5 people is that there will be more hands to help in agricultural activities and also domestic activities (Dercon, 2001) [39] and hence adapt to climate change. The results showed that there was significant different on household size among the two districts ($\chi^2$=6.936, df=2, p=0.031). It was found that there were 46.3% of the farmers in Iramba with more than 5 household members compared with 31.9% farmers in Meatu with more than 5 household members.

### 3.2 Farmers' Adaptation to Climate change Variability

Generally, the level of adaptation to climate change among farmers in the study area was low (Table 3). The majority of respondents (84.7%) fall under very low, low and moderate adaptation compared to only 15.3% who fall under high adaptation. The differences between the districts were significant ($\chi^2$=77.522, df=3, p<0.0001). The frequency indicates that 44.8% of the respondents from Meatu had very low adaptation capacity, while only 7.5% of respondents from Iramba district had very low farmers' adaptation. This could be attributed by the fact that Iramba district is highly affected by floods.

During the focus group discussion participants pinpoint that the frequency of floods in their area reduces their ability to adapt to climate change because they no capacity to control floods. As a consequence, the floods destruct both crops and the pasture for livestock. It was found that due to climate change farmers adapt various practices such improved crop varieties (drought-tolerant and early maturing crops), crop diversification (mixed cropping and crop rotation), farm diversification (mulching, composting) however floods during the crop production season it erode and destruct the crops on the farm. This is in line with the previous study which found that frequency occurrence of the floods was among the factors lowering farmer ability to climate change (Khamis, 2006) [40].

**Table 3:** Farmers' adaptations to climate change (n=183)

| Adaptations category | Iramba | | Meatu | | Total | | $\chi^2$ | df | P-value |
|---|---|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | | | |
| Very low | 5 | 7.5 | 52 | 44.8 | 57 | 31.1 | 77.522 | 3 | <0.0001 |
| Low | 10 | 14.9 | 21 | 18.1 | 31 | 16.9 | | | |
| Moderate | 51 | 76.1 | 16 | 13.8 | 67 | 36.6 | | | |
| High | 1 | 1.5 | 27 | 23.3 | 28 | 15.3 | | | |
| Total | 67 | 100.0 | 116 | 100.0 | 183 | 100.0 | | | |

### 3.3 Determinants of Farmers' Adaptations to Climate change Variability

Multiple regression analysis was used to find the determinants of farmers' adaptation to climate change variability. Results are summarized in Table 4. The overall contribution of independent variables to explain the variance of farmers' adaptation to climate change is 40.9 % ($R^2$) which is highly significant (p<0.0001). This means that the independent variables which were used in the regression model collectively were highly associated with the dependent variable.

**Table 4:** Determinants of Farmers' Adaptations to Climate Change (n=183)

| Variables | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | -1.490 | 0.352 | | -4.234 | 0.000 |
| Age | -0.060 | 0.032 | -0.116 | -1.860 | 0.065* |
| Sex | -0.048 | 0.084 | 0.036 | 0.574 | 0.005** |
| Level of education | 0.101 | 0.061 | 0.103 | 1.642 | 0.102 |
| Marital status | 0.114 | 0.076 | 0.095 | 1.498 | 0.136 |
| Number of household members | 0.008 | 0.019 | 0.027 | 0.432 | 0.666 |
| Entrepreneurial skills | 0.046 | 0.023 | -0.127 | -2.017 | 0.045** |
| Annual income | 0.017 | 0.031 | 0.034 | 0.545 | 0.586 |
| Type of farming | 0.345 | 0.087 | 0.257 | 3.979 | 0.000*** |
| Farm size | 0.003 | 0.009 | 0.021 | 0.334 | 0.739 |
| Distance to the farm | -0.220 | 0.057 | -0.289 | -3.884 | 0.000*** |
| Distance to the market | -0.268 | 0.042 | 0.576 | 6.350 | 0.000*** |
| Distance to source of water | 0.315 | 0.045 | 0.657 | 6.980 | 0.000*** |

R=0.640, R2=0.409 p=.0.000 * significant at p≤ 0.1; **Significant at p=0.05; *** significant at p<0.001

The results found that sex of the head of household had negative contribution ($\beta$ = -0.048, p = 0.005) on farmers' adaptation. The results indicate that male headed households had higher farmers' adaptation than female headed households. Although females are considered to be key actors in farming activities, their ability to adapt to climate change tends to be lower than that of males.

The possible reason for this is that much of the farming activities require access to information to enable them to look for appropriate adaptation measure due to climate change such as access to extension services and early warning information. Previous study have found that in times of climate stresses and shocks like drought, these categories of households tend to have fewer options to find other ways of making a living, because of their very low levels of literacy which reduce their opportunities in coping mechanisms such as wage employment (Nabikolo *et al*., 2012) [41]. This is in line with the study by Kakota *et al*., (2011) [42] in Malawi and Tesso *et al*., (2012) [43] in Ethiopia which found that that female household heads have low ability to adapt to the impact of climate change.

The study found that type of farming performed by the head of the household had significant influence on the household's adaptation to climate change. It was found that majority of the respondents were practicing livestock keeping and crop cultivation. Results showed that respondents who were full engaged on crop cultivation activities had low farmers' adaptation to climate change than those engaging on livestock keeping. This is because people keeping livestock have high chance of engaging on various climate change adaptation options such as engaging on small business after getting capital by selling their livestock. Also, traditional adaptation strategies to climate change variability in Africa consider livestock as an adaptive measure among farmers who have adopted it as a means of diversifying their livelihoods, preserving assets and harnessing marginal resources (WISP, 2010) [44].

The regression results further showed that access to market had negative value ($\beta$ = -0.268, p < 0.0001). This implies that respondents living far from market had less farmers' adaptation compared to those living near the market. This is due to reason that long walking distance to markets is a disadvantageous position for lacking the opportunity of income generation from alternative sources such as non-farm labour, which helps in securing livelihoods during the periods of food shortage or crop failure. Similarly, Hassan and Nhemachena (2008) [13] found that access to market was among the factors which influence adaptation to climate change.

Possessing an entrepreneurial skill by a household head had a positive and significant contribution on the farmers' adaptation. This suggests that the households headed by person with entrepreneurial skills had high farmers' adaptation on climate change. This is similar to the study by Piya *et al*., (2012) [45] which found that respondents who had been provided with entrepreneurial training had the ability to engage in various adaptation measures including undertaking various non-farm activities, which were less climate-sensitive compared to the farming and gathering, thereby enabling the household to adapt to the impact of climate change.

However, the results indicate that the relationships between farmers' adaptation and age, marital status, level of education, household size, and farm size, annual income were not significant. This is contrary to previous studies done by Daulagala *et al.,* (2014) [3] and Notenbaert *et al*., (2013) [46] which found some of these were the determinants of households' adaptation to climate change.

## 4. Conclusions and Recommendations

Generally, the study concludes that farmers' adaptation to climate change mainly depends on the socio-economic characteristics. Households headed by females tend to have lower ability to adapt to climate change variability than those headed by males. Household full engaged on crop cultivation activities had low farmers' adaptation to climate change than those engaging on livestock keeping. This is because people keeping livestock have high chance of engaging on other adaptation options such as engaging on small business after getting capital by selling their livestock. Household living near to the market and water sources had high adaptation to climate change variability. In addition, the study concludes that entrepreneurial skills possessed by households' heads increase farmers' adaptation. This is because households headed by person with entrepreneurial skills have the training and skills which will enable to engage in various adaptation measures including undertaking non-farm activities which are less climate-sensitive compared to the farming. It was also revealed that on the level of adaptation to climate change variability, farmers from Meatu District had very low adaptation compared to those from Iramba District.

Due these results, the study recommends improving ability of the household to adapt to climate change variability by increasing farmers' adaptation such as through constructing sources of water and markets near to the villages but also empowering female farmers and crop producers with knowledge and skills which will enable them to adapt to climate change. The study also recommends the government and nongovernmental organization effort should empower farmers with entrepreneurial skills which will enable them to create opportunities and help them engage on non-farm activities.

## 5. Acknowledgement

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