International Journal of Research in Social Sciences
Vol. 7 Issue 7, July 2017,
ISSN: 2249-2496 Impact Factor: 7.081
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

FARM BASED ADAPTATION STRATEGIES TO CLIMATE CHANGE AMONG SMALLHOLDER FARMERS IN MANYONI DISTRICT, TANZANIA

Andrew Omari Shirima [*]

Galinoma Lubawa [**]

ABSTRACT

Climate change is a global challenge to both sustainable livelihoods and economic development. In Tanzania farming depends almost entirely on rainfall, a situation that makes agriculture vulnerable to climate change. This study investigated the adaptation strategies adopted by smallholder farmers in Manyoni District.The specific objectives were to determine the adaptation strategies by smallholder famers and examine adaptation strategies by socio-demographic factors. The study adopted cross-sectional design. Multistage sampling technique was adopted to randomly select four wards, eight villages and 240 respondents; 30 from each village. Primary and secondary data were collected. Data were collected using questionnaire survey and FGDs. Qualitative data were analyzed using content analysis whereas quantitative data analysis was done using SPSS for descriptive statistics. Adaptation strategies were shifting cultivation, staggered cropping, cultivation of short time crops and cultivating drought resistant crops. The identified adaptation strategies were mainly selected by majority of those who owned land, and most of them were those who had non-formal education. The study concludes that the adaptation strategies that were mainly adopted were farm-based. Majority of the smallholder farmers with non-formal education were the ones that had adapted. Most (69.6%) of the respondents with non-formal education adopted the soil fertility improvement practice. Also many of the identified adaptation strategies were identified by the respondents that were 51 years old and above. Most of those with above three acres were the ones that responded to have adapted and that majority that practiced the adaptation strategies owned land. The study recommends intensification of farm based adaptation strategies for a more sustained adaptation. It also recommends sensitization of smallholder farmers for proper household land use plan by District Council organs so that farmers can make proper land use decisions for proper adaptation strategies.

Kew words: Climate change, variability, adaptation, smallholder farmers, Manyoni.

[*] Department of Community Development, University of Iringa

[**] Department of Development Finance and Management Issues, Institute of Rural Development Planning

1. Introduction

Adaptation is a critical agricultural development issue and of concern in developing countries, particularly in Africa where vulnerability is high (Hassan and Nhemachena, 2008). It is projected that reduction in yield in some African countries could amount to 50% by 2020, whereas net crop revenues might fall by 90% by 2100 (Boko *et al.,* 2007). This amounts to a serious threat to food security and achievements of major developmental goals such as Millennium Development Goal number one that aims at eradicating extreme poverty and hunger.

In Tanzania, climate is highly variable and complex, and climate trends indicate that temperature is rising and rainfall is becoming more erratic. Recent findings show that average annual temperature will rise by 1ºC by 2050 and changes in rainfall patterns could cause dramatic shifts in agro-ecological zones, increase uncertainty in the onset of the rainy season, and increase the severity of droughts and floods and subsequently affect agriculture (URT, 2014). According to URT (2007), most of the agricultural production which is the main source of employment and livelihood for more than-two thirds of its population is rain fed. This situation exposes agriculture to severe effects of climate change and variability such as decreased production of different crops largely associated with recurrent droughts, floods, increasing crop pests and diseases and shift of growing seasons. Adger*et al.* (2003) report that climate change will have a more severe impact on the poor farm households because they have the lowest capacity to adapt to changes in climatic conditions hence the need for them to device some measures to adapt to extreme weather conditions.

Smit and Skinner (2002) and Adger*et al.* (2007), as quoted by IFPRI (2010) report that in agriculture, adaptation is evolutionary and occurs in the context of climatic, economic, technological, social, and political forces. Adaptation to climate change varies contextually and spatially within communities and even within individuals, hence a need for assessing adaptation to climate change taking into account variations of space, people, time and context. Adaptation is an iterative, dynamic, multiscale, and multi-actor process, not a mechanical adjustment to a current state (Osbahr*et al.,* 2008).

Studies by Agrawal*et al*. (2008) and Odjugo, (2010) have reported adaptation strategies undertaken in response to climate variability and change in drought and flood-affected areas to

protect families, assets and enhance food security. Egyir*et al.* (2015) assessed adaptive capacity and coping strategies in the face of climate change in communities around two protected areas in the coastal Savanna and Transitional zones of Ghana.

Balama*et al.* (2013) assessed climate change adaptation strategies by local farmers in Kilombero District and found that farmers had developed local adaptation strategies such as crop diversification for food and cash and shift of cropping calendar. Similarly, Komba and Muchapondwa (2015) assessed adaptation to climate change by smallholder farmers in Tanzania and found that farmers had generally used short-season crops, drought-resistant crops, irrigation, changing planting dates and tree planting to adapt to the negative impacts of climate change on their agricultural yields.

On the same basis, Mary and Majule (2009) assessed the impacts of climate change, variability and adaptation strategies on agriculture in semi-arid areas of Tanzania but focusing on only two villages of Manyoni with no focus on the factors that influence adaptation among smallholder farmers. Also it did not categorically examine smallholder farmers farm based adaptation strategies hence a need to exclusively assess smallholder farmers' farm based adaptation strategies and the factors that influence it.

Therefore, available information on the adaptation strategies to climate change and the influencing factors in the context of smallholder farmers in Manyoni are general and insufficient.

In the context of smallholder farmers in Manyoni, this study, therefore, aimed at (i). investigating the farm based adaptation strategies adopted by smallholder famers and (ii). Examining the demographic and socio-economic factors that influence adaptation of strategies among smallholder farmers. Upon filling in this knowledge gap policies will be informed on the existing state of adaptation to climate change thereby being in a position to reformulate more relevant and contextual measures.

2. Methodology

2.1 Description of the study area

This study was done in Manyoni District in Singida Region, Tanzania. The district is found in the semiarid areas of Tanzania where there are recurrent food scarcity incidents due to uncertainty of rainfall (URT, 2005). Manyoni District has a unimodal rainfall regime that occurs between November and April. The mean annual rainfall is 624 mm with a standard deviation of 179 mm. The mean number of rainy days is 49 with a standard deviation of 15 days. On temperature, annual mean, maximum and minimum monthly temperatures in the district are 22˚C, 24.4˚C (November) and 19.3˚C (in June) respectively (Mary and Majule, 2009).

The study was carried out in four randomly selected wards of Manyoni District namely Itigi, Itigi-Majengo, Manyoni and Mitundu wherein, two villages from each Ward were randomly selected. The selected villages were Itigi, Mitundu, Muhalala, Kipondoda, Zingilani, Manyoni, Majengo and Tambukareli.Manyoni District falls within the semi-arid areas of Tanzania and there is often food insecurity and where their dependence on rainfall exceeds 95% (NBS, 2009). According to URT (2013) the district falls within regions with worst assessment of food poverty.

2.2 Research design, sampling procedure, sample size and methods of data collection

The study adopted a cross sectional research design where data were collected at a single point in time. This design was chosen because it has a greater degree of accuracy and precision in social science studies than other designs (Casley and Kumar, 1998). The nature of the objectives demanded collection of data to be done in a single point in time. The unit of analysis of the study was smallholder farmers in Manyoni District. The sample was obtained using simple random sampling technique from a sampling frame of smallholder farmers from village register books. From each village, 30 households were randomly selected. A total of 240 households were involved in this study. The key informants involved in the study were Ward Agriculture Extension Officers and District Agriculture Officer, Village and Ward executive officers who were selected because they deal in issues of agriculture and administration at the district level. Qualitative data were collected from 13 key informants 8 focus groups (consisting of 8-12 people). These were chosen on the basis of seniority in age in view that they are more experienced in farming, climate change scenarios and adaptation.

Both primary and secondary data were collected. Quantitative data were collected using a structured questionnaire which was administered to 240 heads of households. Secondary data were compiled from existing information sources such as weather reports from Tanzania Meteorological Agency (TMA) and social economic information from the Manyoni District Council.

2.3 Data analysis

Qualitative data were analyzed using content analysis techniques whereby data were categorized into themes and summarized into meaningful information. Quantitative data analysis was done using SPSS where descriptive statistics were applied. The influence of socio-demographic factors and adaptation strategies was inferentially measured using multiple linear regression. The adaptation strategies which are the dependent variable were determined by counting the number of strategies adopted by the farmers in the study area. This model was adopted given the fact that it meets the basic assumptions such as having at least three variables that are of metric (ratio or interval) scale and the relationship between the independent and dependent variables being linear. Regression was also done since it is useful in finding the relation/influence.

The multiple linear regressions is specified as follows:

$q_{it} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \beta_{10} x_{10} + \varepsilon$ (Landau and Everitt (2004)

where q_{it} = Adaptation strategies

$\beta_{0=}$ Constant

β_{1-6} = Coefficients of regression

x_{1-6} = Independent variables

$x_{1=}$Age (number of years)

$x_{2=}$Sex (1=Male 0=Otherwise)

$x_{3=}$ Marital Status (1=Married 2= otherwise)

$x_{4=}$Education Level (Number of years in schooling)

$x_{5=}$Relatives (1= having relatives, 0=otherwise)

$x_{6=}$Participation in decision making (1=participate, 0=otherwise)

$x_{7=}$ Credit access (1=Access, 0=Otherwise)

$x_{8=}$ Land ownership (1=Do own, 0=otherwise)

$x_{9=}$ Land size (Measured in Acres)

$x_{10=}$ Bank Savings (1=Have savings, 0=Otherwise)

ε = error term

3. Results and Discussions

3.1 Socio-demographic characteristics of the respondents

Table 1 indicates that 60% of the respondents were married with most (67.1%) having non-formal education. Table 1 further shows that 32.5% of the respondents had a household size ranging from 5 to 6 members whereas 21.2% of them had 1 to 2 members. This number of household members is relatively higher than the Tanzania Mainland average house hold size which is 4.8 (URT, 2013). Table 2 further shows that 87.5% of the respondents owned land out of whom 62.1% owned one plot.

Table 1: Socio-demographic characteristics of the respondents (n=240)

Education level of the respondents	**Frequency**	**Percent**
Non Formal	161	67.1
Primary	54	22.5
Lower Secondary	11	4.6
Upper Secondary	4	1.7
Tertiary	10	4.2
Total	**240**	**100.0**
Household size of the respondents		
Number of members	**Frequency**	**Percent**
1-2	51	21.2
3-4	72	30.0
5-6	73	30.4
Above 6	44	18.3
Total	**240**	**100.0**
Land ownership and Farm plot characteristics		
Parameter	**Frequency**	**Percent**
Own Land	210	87.5
Do not own land	30	12.5
Total	**240**	**100.0**

Estimated Size of plots in Acres	Frequency	Percent
1 - 2 Acre	65	27.1
2-3 Acre	57	23.8
Above 3 Acres	118	49.2
Total	**240**	**100.0**

3.2 Adaptation strategies undertaken by smallholder farmers

Smallholder farmers undertake various adaptation strategies in the face of climate variability and change. It was found that adaptation strategies that were adopted by smallholder farmers were mainly farm-based. Cultivation of short time crops was a strategy that was identified by 35.9% of the respondents. They were of the opinion that planting short time maturing crops is a feasible strategy for enhancing adaptation of smallholder farmers to climate variability and climate change in the study area. The cultivation of early maturing crops was a necessary strategy to adapt to changes in the onset and offset of rainfall. This was reported in FGDs whereby it was mentioned that farmers were used to plant crops in October/November but during the year of this research planting was done in December/January due to variation of timing in rainfall implying that the rain period was relatively shorter. Planting early maturing crops is found to be a viable solution to farmers to avoid a dry spell as also reported by Mongi*et al*. (2010). Production of short time crops is in line with the findings of Andresen (2008) about the shortening of the growing season in parts of central Tanzania, including Manyoni District.

Staggered cropping was another strategy that was identified by about 21% of the respondents. This is a type of farming whereby farmers use more than one plot for crop production. To avoid crop production effects due to rainfall variability and drought, crops are also planted before rain onset (dry land) on uncultivated land while crops are planted in other plots immediately after rain, and still other plots are planted a few days after the first rains. This is a practice that aims at distributing farming effects given the semi-arid nature of the study area. It was further noted that staggered cropping was a possible adaptation strategy for some, given the traditional inheritance of land acquisition. However, it was further reported that this strategy was partly impaired by limited access to labour and seeds, all of which were said to be expensive. The adoption of staggered cropping is in line with the views of Schechambo and Kisanga (1999) who assert that the climate of semi-arid areas of Tanzania (Manyoni being one of them) experiences dry spells

within the growing season and therefore, as a consequence of this spatial-temporal variation in rainfall, farmers practise staggered planting in order to overcome this situation

Shifting cultivation was identified by 21.5% of the respondents as another adaptation strategy that is adopted to address climate change. It was a strategy that aims at leaving for a season or more an already cultivated plot so as to regain its fertility. This practice was mostly adopted by those that had enough land to till implying that those who had a limited size of land could not adopt this strategy.

Cultivation of drought resistant crops was also identified by 16.4% of the respondents. This is aiming at accumulating crop stocks during drought or being in a position to harvest even when there are dry spells in an area. During interviews and focus group discussions it was noted that the drought resistant crops commonly grown include cassava, millet and sunflower. It was further observed that the cultivation of such crops in Manyoni District and the Singida Region as a whole is mandatory. On this, a respondent in Mitundu Village remarked:

> *....in spite of the fact that food production is a family issue, the government (Regional Commissioner) has ordered farmers to grow drought resistant crops, failure of which results in being left helpless in times of food shortage. It's an obligation that has to be observed".*

Being an obligation, this strategy is partly not owned by the smallholder farmers, the result of which is hesitation to its adaptation. This strategy ranked the third in terms of the percentage of respondents that reported to have adopted it. Cultivation of drought resistant crops in semi-arid areas is also reported by Kihupi *et al.* (2015) who observed the adoption of drought resistant crops in response to climatic change experienced by households in Pawaga and Ismani Divisions.

Other adaptation strategies that were reported were improvement of soil fertility by the application of fertilizers and manure and refraining from growing certain crop varieties. These were reported by 3.9% and 0.5% of the respondents respectively. Refraining from cultivation of certain crops was partly caused by the government's order to cultivate drought resistant crops and also by crop failures due to change in climate and variability.

Table 2: Adaptive strategies undertaken by smallholder farmers (n=240)

Adaptation strategies	Responses		Percent of Cases
	N	Percent	
Production of short time crops	211	35.9	87.9
Staggered cropping	128	21.8	53.3
Shifting Cultivation	126	21.5	52.5
Growing drought resistant crops	96	16.4	40.0
Improving soil	23	3.9	9.6
Refraining from cultivating crops	03	0.5	1.2
Total	**587**	**100.0**	**244.6**

Note: Multiple responses

3.3 Influence of socio-demographic characteristics of farmers to adaptation

Multiple linear regression was used to determine the influence (impact) of socio-demographic characteristics of farmers (independent variables) to adaptation strategies (dependent variable) in Table 3. Negative and positive influence denoted by negative and positive signs respectively of standardized regression coefficients known as beta-weights while symbol is β (Bryman and Cramer, 1993). The dependent variable was regressed on 10 independent variables which were included because they were thought to be able to acount for more of the variation in the adaptation strategies. The reminder of the variation would be due to independent variables not included in the model, incorect model formulation and erros in the research (Mendenhall and Beaver, 1991). Before regression was done the 10 independent variables and the dependent variable were checked for normality by computing their normal curves, which were then checked visually to find whether any of them was unevenly distributed. Checking for normality was done because linear regression requires that all the variables are normal. The correlation coefficient between the dependent variable and all the independent variables together R was 0.750, which was relatively high implying that the independent variables collectively were highly related to the dependent variable. The adjusted coefficient of determination (R^2) was 0.544 meaning that the independent variables included in the regression model explained 54% of the variation in the

dependent variable; the rest of the variation was due to other variables not included in the model and inherent errors in the model. The tolerance and VIF values of collinearity, which were greater than 0.1 and not more than 10 respectively, show that there was no multicolinearity (Landau and Everitt, 2004).

Table 5 shows that six variables had a significant influence on adaptation strategies. Sex of the household head had β= -0.132, p=0.005. This is partly caused by the fact that majority (74.2%) of the involved household heads were males relative to women the fact that exposes women to a relatively limited access to resources as compared to men. This assertion is also supported by Ellis and Mudhara, (1995) that showed that, female household have less access to improved technologies, credit and extension service a fact that inhibits their farming decisions. This finding implies that household adaptation strategy decisions and actions are male based a fact that can impair effective adaptation. Male headed households have better access to information and farming decisions than female households that helps for adoption of climate change adaptation strategies. Marital Status was also found to have a negative significant (β= -0.113, p=0.014) influence of adaptation. This implies that, the variable relates negatively and significantly to the adaptation strategies. This finding is in line with the findings of Nabikolo*et al*. (2012) who also found that sex of the household head are negatively associated with climate change adaptation.

Participation in decision making was found to have a positive significant influence of adaptation (β = 0.262, p=0.000). This means that, with involvement of household members in decision making and actions, adaptation is positively influenced. This is partly caused by the fact that household members act as household production units, involvement of whom impacts farming and farming decisions. This finding implies that the households that manage to do farming while effectively involving household members in decision making become relatively more effective in terms of adaptation. This is supported by Holstein (2000) who underscores the need of involvement of stakeholders in climate adaptation strategies.

Access to credit access was also found to have a significant (β = 0.400, p=0.000) positive influence on adaptation. This is partly caused by the fact that access to credit facilitates farmers to address farming needs that require funds in spite of the fact that less than 50% of the

respondents reported to have credit access. This implies that with access to credit famers will be able to access farming facilities and technologies that will facilitate adaptation. This is in line with the findings of Nhemachena and Hassan (2007) that identified credit as an important determinant of adaptation in South Africa, Zambia and Zimbabwe among other determinants.

Land ownership was also found to have a significant positive influence (β=0.400, p=0.000). This means that, with land ownership farmers are able to make adaptation decisions independently relative to those that do not own land. Renting land has is associated with conditions that impair free farming decisions resulting to restricted adaptation for a farmers that rents land. This implies that much as land ownership has a positive significant implication in adaptation, surveyed smallholder farmers are in a position to decide freely on their adaptation practice. This finding is supported by Nhemachena and Hassan (2008) whose findings from a study in Ethiopia asserted that farmers who owned their land are more likely to invest in adaptation options, including crop management practices and conservation

Bank Savings had negative impact on adaptation which was significant (β =-0.100, p=0.047). It was expected that bank savings would be positive; nevertheless it was not the case more likely due to the fact that it was only very a few that had bank savings.

Table 3: The influence of socio-demographic characteristics of farmers and adaptation (n=240)

Independent variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	2.546	0.447		5.701	0.000		
Age	0.000	0.004	0.001	0.032	0.974	0.964	1.037
Sex	-0.417	0.147	-0.132*	-2.832	0.005	0.877	1.140
Marital Status	-0.318	0.128	-0.113*	-2.480	0.014	0.923	1.084
Education Level	0.023	0.015	0.072	1.499	0.135	0.816	1.225
Relatives	0.216	0.197	0.051	1.097	0.274	0.880	1.137
Participation in decision making	0.980	0.178	0.262*	5.513	0.000	0.846	1.182

Credit access	1.283	0.158	0.400*	8.102	0.000	0.782	1.278
Land ownership	1.085	0.140	0.387*	7.768	0.000	0.769	1.300
Land size	-0.156	0.081	-0.095	-1.916	0.057	0.771	1.297
Bank Savings	-0.361	0.181	-0.100*	-1.998	0.047	0.756	1.323

$R=0.750$, $R^2=0.563$, Adjusted $R^2=0.544$, Std. Error of the Estimate= 0.93430, $T=5.701$ ($p=0.000$).

The dependent variable: adaptation strategies.

Note: * represent statistical significant levels at $p \leq 0.05$.

4. Conclusions

It was found that smallholder farmers adaptation strategies were mainly farm based whereby the commonly applied ones were shifting cultivation, staggered cropping, cultivation of short time crops and cultivating drought resistant crops. This means that any improvement of adaptation strategies should depart from farms much as smallholder farmers have concentrated their adaptation practices within their farms.

It further concludes that, sex, marital status, participation in decision making, credit access, land ownership and bank savings had a significant relationship with the adaptation strategies undertaken by smallholder farmers with sex and marital status having as significant relationship with adaptation. Of all the variables that had significant influence, sex, marital status and bank savings had a significant negative influence connoting that they influence adaptation negatively.

5. Recommendations

In view of the findings and conclusions, it is recommended that, the Ministry of Agriculture and Livestock through District Council in collaboration with smallholder farmers should intensify farm based adaptation strategies for a more sustained adaptation. They should formulate community based adaptation mechanisms such as collective farming for easy access to agricultural services; block water harvesting and proper farming land use planning.

The study further recommends that women and men be sensitised by local government authorities and other partners such as Non-Governmental organisations so as to be equal parties in decision making in issues of climate change and adaptation. Smallholder farmers should as well be sensitised on bank saving culture so they are able to effectively access adaptation tools such as technology which they cannot access if they don't have financial power.

References

Adger, W. N., Huq, S., Brown, K., Conway, D. and Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in Development Studies* 3: 179-195.

Agrawal, A. (2008). Climate Adaptation, Local Institutions and Rural Livelihoods. [http://www.umich.edu/~ifri/Publications/] site visited on 5/6/2015.

Andresen, J., Olson J. and Yanda, P. (2008). The Effects of Climate and Land Use Change on Climate and Farming Systems in Tanzania. [http://clip.msu.edu/Policy] site visited on 6/9/2015.

Balama, C., Augustino, S., Eriksen, S., Makonda, F.S.B. and Amanzi, N. (2013). Climate change adaptation strategies by Local Farmers in Kilombero District, Tanzania. *Ethiopian Journal of Environmental Studies and Management* 6: 724-736.

Boko, M., Niang, A., Nyong, A., Vogel, C., Githeko, M., Mednay, B., Osman Elasha, R., Tabo and Yanda, P. (2007). Africa. [https:// www. ipcc.ch/ pdf/assessment-report/ar4/wg2/ar4-wg2-chapter9] site visited on 6/9/2015.

Bryman, A. and Cramer, D. (1993).*Quantitative Data Analysis for Social Science Scientists*.Routledge, London. 290 pp.

Casley, D. J and Kumar, K. (1998). *The collection, Analysis and use of Monitoring and Evaluation of Data.* The International Bank for Reconstruction and Development. Washington, D.C. 160pp.

Egyir, I. S., Ofori, K., Antwi G. and Ntiamoa-Baidu, Y. (2015).Adaptive Capacity and Coping Strategies in the Face of Climate Change in Protected Areas in the Coastal Savanna and Transitional Zones of Ghana.*Journal of Sustainable Development* 8 (1): 1-15.

Hassan, R. and Nhemachena, C. (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal of Agricultural and Resource Economics* 2(1): 83-104.

Holstein, A. N. (2000). Grabs Expert Paper 2: Participation in climate change adaptation. [http://www.grabs-eu.org/downloads/Expert_Paper_Climate_Participation_FULL_VERSION%28mk3%29] site visited on 12/2/2016.

IFPRI, (2010). Micro-level Practices to Adapt to Climate Change for African Small-scale Farmers. [http://www.preventionweb.net/files/12863_IFPRIfeb2010] site visited on 6/3/2015.

Kihupi M. L., Chingonikaya E.E. and Mahonge C. (2015). Smallholder Farmers' Perception of Climate Change Versus Meteorological Data in Semi-arid Areas of Iringa District, Tanzania. *Journal of Environment and Earth Science* 5(2): 137-147.

Landau, S.and Everitt, B.S. (2004). *A Handbook of Statistical Analyses using SPSS*. Chapman and Hall/CRC Press LLC, Washington., D.C. 337 pp.

Mary, A. L. and Majule, A. E. (2009). Impacts of climate change, variability and adaptation strategies on agriculture in semi arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. *African Journal of Environmental Science and Technology* 3(8): 206-218.

Mendenhall, W. and Beaver, R.J. (1991).*Introduction to Probability and Statistics*. PWS-Kent Publishing Co., Boston. 106pp.

Mongi, H., Majule, A. E., and Lyimo, J. G. (2010). Vulnerability and Adaptation of Rain fed Agriculture to Climate Change and Variability in Semi-arid Tanzania. *African Journal of Environmental Science and Technology* 4(6): 371-381.

National Bureau of Statistics (NBS) (2009).Household Budget Survey 2007. [http://www.nbs.go.tz/tnada/index.php/catalog/] site visited on 6/9/2015.

Nhemachena, C. and Hassan, R. (2007). Micro - level Analysis of Farmers' Adaptation to Climate Change in Southern Africa [https://ipcc-wg2.gov/njlite_download2.php] site visited on 12/2/2016.

Nhemachena, C. and Hassan, R. (2008). How can African agriculture adapt to climate change: Insights from Ethiopia and South Africa micro-level analysis of farmers' adaptation to climate change in southern Africa. [http://www.gaiafoundation.org/sites/default/files/documents/IFPRI%20-%20Adaptation%20Climate%20Change.pdf] site visited on 12/2/2016.

Odjugo, P.A.O. (2010). General Overview of Climate Change Impacts in Nigeria.*Journal of Human Ecology* 29(1): 47-55.

Osbahr, H., C. Twyman, W. N. Adger, and D. S. G. Thomas. (2008). Effective Livelihood Adaptation to Climate Change Disturbance: Scale Dimensions of Practice in Mozambique. *Geoforum*39(6): 1951–1964.

Schechambo, S. and Kisanga, D. (1999).Rethinking Natural Resource Degradation in Semi-Arid Sub-Saharan Africa: The Case of Semi-Arid Tanzania. [http://www.tanzaniagateway.org/docs/tzlit] Site visited on 18/3/2015.

URT (2005).*Singida Region Socio-Economic Profile*.National Bureau of Statistics, Dar es Salaam and Regional Commissioner's Office, Singida. 91pp.

URT (2007). *National Adaptation Programme of Action (NAPA).* Division of Environment, Vice President's Office, Dar es Salaam. 52pp.

URT (2013).*2012 Population and housing census: Population Distribution by Administrative Areas.* National Bureau of Statistics Ministry of Finance Dar es Salaam. 224pp.

URT (2014). *Tanzania Agriculture Climate Resilience Plan 2014-2019.* Ministry of Agriculture Food Security and Cooperatives. Dar es Salaam. 35pp.