Mamkwe C. Edward/Uongozi Journal of Management and Development Dynamics Vol. 27(1) (2016) 85- 114

Household Socio-Economic Factors and Adoption of Climate Change Adaptation Strategies: The Case of Same District, Tanzania

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Abstract

This paper is a result of a cross sectional survey conducted in Same District to analyze the influence of household socio-economic factors on adoption of climate change adaptation strategies. Primary data were collected through questionnaire administered to 113 small farming households. Secondary data were obtained through documentary review. Frequencies, percentages, Chi-square test and binary logistic model were used to interpret the data. Chi-square test showed that the use of improved seeds was statistically associated with farm size, age and education level of the household head while use of fertilizer was associated with household size and farm size whereas intercropping had statistical association with farm size. Binary logistic model results indicated that a unit increase of farm size decreased the probability to use improved seed and increased the probability to use fertilizer. A unit increase of age below 30 years decreased the probability to use inter-cropping; it increased the use of on-farm rain water harvest. The study concluded that adoption of different climate change adaptation strategies is influenced by age, household size and farm size. It is recommended that formulation of climate change policy should *consider the influence of socioeconomic factors such as household size, farm size and age on adoption of adaptation strategies.*

Key words: *Climate change, adaptation strategies,*

1.0 Introduction

Climate change is a problem of global concern and a major challenge to the international community today. Negative effect of climate change is a threat to development efforts that had been laid down in different sectors like agriculture, health, environment and infrastructures (Wood *et al*., 2014; IPCC, 2014). Climate change will cause more sufferings in developing countries than developed countries (Etwire *et al.*, 2013, Okonya, 2013; Shackleton *et al*., 2015) because of shortage of resources to cope with the effects. Developing countries naturally are placed in rather generally vulnerable locations (IPCC, 2007).

African countries including Tanzania are especially vulnerable to the effects of climate change because of over dependence on rain-fed agriculture, recurrent droughts, weak policies, and widespread poverty (Shemsanga, 2010, Bryan *et al.*, 2013, Phiri, 2016). Extreme vulnerability to the negative effects of climate change coupled with the low capacity to adapt to the changes increases the risk of small farmers' livelihood sources for food security (FAO, 2014; Hisali *et al*., 2011). Food security for small farming household in many cases is associated with low production and accessibility (FAO, 2014; Salau *et al.*, 2012; Regassa, 2011; Hassan and Nhemachena, 2008).

According to International Panel on Climate Change (IPCC) report (2014), adaptation refers to adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. On the other hand, climate change adaptation strategies refers to as process which moderates, make advantages of the effects or enhance the capacity of the system to cope with the event (UNDP, 2008). This paper adopts a definition of adaptation strategies meaning those factors that enhance the capacity of the agricultural system to cope with the environmental changes. The use of improved seed, fertilizers, intercropping and on-farm rain water harvesting increase the likelihood of crop harvesting despite the consequences of climate change.

Notwithstanding different ways of defining adaptation to climate change it is worth noting that people (as part of socio-ecological systems) adapt reactively and autonomously to the effects or impacts of climate change. People pursue adaptation strategies appropriate to their individual circumstances (Brooks and Adger, 2016). The capacity of a household to adapt to the changing ecological and social systems due to climate change is determined by its socio-economic characteristics. The socioeconomic factors have a big role to play in the ways farming households adapt to impacts of a changing climate (Deressa *et al.*, 2011; Dinshaw *et al.*, 2014, Jacobs, 2015, Phiri, 2016). Small farming households in semi arid areas are less resilient to climate related disasters. They are recognised as the most ecologically marginalized people and that climate change account for an additional stressing factor in such a vulnerable agricultural system with low capacity to adapt (Nabikolo *et al.*, 2012; Gbetibouo, 2009; Gunkurume, 2013).

Strategic investments are needed to improve agricultural productivity under such climate risk.

Under the uncertainty of agriculture and climate change risks adaptation is a paramount priority for developing country like Tanzania for national socio-economic development (URT, 2012). However, farm-level adaptation strategies of small farming households in Tanzania and particularly semi-arid areas are scarcely understood and documented. The objective of this paper is to analyze the influence of household socio-economic factors on adoption of improved seeds, fertilizers, intercropping and on-farm rain water harvesting as climate change adaptation strategies. Specifically, it describes socio-economic characteristics in relation to climate change adaptation strategies, specifically use of improved seeds, fertilizer, intercropping as well as on-farm rain water harvesting and to determine the influence of socio-economic factors on the adoption the above mentioned as climate change adaptation strategies**.**

2.0 Methodology

The study employed a cross sectional research design in which data was collected once (Sedgwick, 2014). This design is suitable for descriptive as well as inferential analysis and allows for determining the relationships between and among variables (Sedgwick, 2014). The survey was conducted in two villages namely Njoro and Bangalala in Same District, Tanzania. Farming households formed the unit of analysis while heads of households were respondents of the study. Purposive sampling technique was used to select the study district, wards and villages in order to include those villages located in semi arid areas. In each village, the households were selected using simple random sampling technique from the village register books which formed the sampling frame.

In obtaining a significant representation of the population the study employed a Boyd's formula, denoted by C = n/N*100 where C represents a figure greater or equal to 5% of the village households, N is the total number of households in the village and n is the number of selected households. According to Boyd *et al*. (1981) a significant representation is achieved when a sample of equal or greater than 5% of the total population is taken for a study. In this case a sample size of 113 households was selected for the questionnaire based survey.

The study used questionnaire method for collecting data. In this method, a structured questionnaire with both closed and open ended questions was used to collect data among other things on socioeconomic characteristics and the use of improved seed and fertilizer as climate change adaptation strategies by the households. Collected data covered the independent and dependent variables of the study. Independent variables were the socio-economic factors such as age, sex, education level (in terms of categories of highest level of education attained, as primary, secondary, above secondary and no formal education for those who had not attended any formal school), household size, income and farm size. Dependent variables included climate change adaptation strategies such as the use or non use of improved seeds, and fertilizers. The use or non use of adaptation strategies were dummy variables which were assigned (1) if was used by the households and (0) if otherwise. The independent variables were nominal and categorical.

Data were analyzed by using descriptive statistics such as frequencies and percentages to show the distribution of the respondents by their socio-economic characteristics and the distribution of adopted climate change adaptation strategies, improved seed and fertilizers. Also, chi-square test and binary logistic model were used to examine the association between climate change adaptation strategies and a common set of the socio-economic characteristics. This method helped to delineate independent variables which have statistical significant effect on the dependent variables (Gujarati, 2004; Sedgwick, 2014). In the binary logistic regression, the dependent variable was whether or not the household was using the above mentioned climate change adaptation strategies. Use or non use of these adaptation strategies was analyzed as a function of the independent variables (socio-economic factors).

The model is specified as follows:

Yi = log (pi/1-pi) = b0 + b1x1 + b2x2 + … + bkxk where:

pi = prob (event), that is the probability that the event will occur (probability of the household i using the climate change adaptation strategy).

1-pi = prob (non-event), that is the probability that the event will not occur (non probability of the household i using the climate change adaptation strategy).

b0 = constant term

b1 to bk = parameters to be estimated

k = number of independent variables

x1 to xi = independent variables entered in the model, which were: x1 = age, x2 = sex, x3 = education level, x4 = household size, x5 = main income source, x6 = household income and x7 = farm size

3.0 Results and Discussion

3.1 Background Characteristics of Respondents

The studied background characteristics of the respondents focused on sex, age, marital status, level of education, household size, sources of income, household income, and farm size of the households. Certain background characteristics may be associated with some factors that may have some bearing on adoption of household climate change adaptation strategies.

The results in Table 1 show that 53.7% of the respondents were men while women were 46.3%, indicating higher proportion of male than female respondents. This gender difference was attributed to the fact that the society in the study area is patriarchal, whereby majority of the heads of households were men. However, the proportion of female headed households in the study area was higher for this study than the national figure which is 23.1% (NBS, 2009). This phenomenon was attributed to the fact that some respondents were widows and others were unmarried women (singles). Another reason associated with the relatively high proportion of female headed households was high out-migration of men to look for alternative livelihoods, other than rain-fed agricultural production. Incident of men out-migration was attributed to low returns from agricultural production including food production associated with the impact of climatic conditions especially recurrent and prolonged droughts. This phenomenon of men out-migration was also reported by Chindarkar (2012) that rural-urban out-migrants are mainly men and youth.

Also, the results in Table 1 show that 82.2% of the respondents were between the age of 30 and 50 years, while 14.8% were at the age of above 50 years, and 3.0% were below 30 years. This difference was attributed to the fact that young adults tend to be household heads only after marriage when they detach themselves from their parents. These results show that the majority of the respondents were at the active production age and, hence, were aware of the changes in climatic conditions that affected agricultural production and ultimately food security which compelled them to consider various adaptation strategies.

The findings also show that 51.5 % of the respondents had four to six household members, 34.5% of the respondents had seven and above members, while 14% of the respondents had less than four members, in Table 1. These results are in line with the average household size of the whole Kilimanjaro Region, where Same Districts belong, which is 5.2 on average (URT, 2006).

Education level of the respondents was another socio-economic characteristic in this study. It was measured in terms of the highest level of education one had attained. The findings in Table 1 indicate that 70.3% of the respondents had attained standard seven, while 16.2% of the respondents attained standard four, and 10.9% of the respondents had never attended any formal schooling. Only 2.6% of the respondents had gone beyond standard seven level of education. This shows that the majority of the respondents had attained basic education of seven years in school while a few had never gone to school. Similarly, the National Household Budget Survey of 2007 found that the majority of the people in rural Tanzania were mere standard seven leavers (URT, 2013). This shows that most of the respondents had basic education that could enable them recognise some climatic changes that influenced their livelihoods including food production as the main determinant of food security for rural farming households.

Table 1: Distribution of respondents by their background characteristics

Background characteristic		Village		Total (n=113)
		Bangalala (n = 56)	Njoro (n = 57)	
		%	%	%
Sex	Male	34.1	19.6	53.7
	Female	15.8	30.5	46.3
Age (years)	<30	0.4	2.6	3.0
	30 – 50	41.1	41.1	82.2
	>50	8.2	6.6	14.8
Education level	No formal education	5.3	5.6	10.9
	Standard 4	8.3	7.9	16.2
	Standard 7	34.0	36.3	70.3
	Sec. school and above	2.2	0.4	2.6
Household size (number of people)	<4	4.8	9.2	14.0
	4 – 6	26.6	24.9	51.5
	≥7	18.3	16.2	34.5
Main income sources	Crop	30.1	24.9	55.0
	Livestock	18.4	19.2	37.6
	Small business	1.3	5.7	7.0
	Salary	0.0	0.4	0.4
Farm size (Hectare)	<1	4.3	1.8	6.1

Background characteristic		Village		Total (n=113)
		Bangalala (n = 56)	Njoro (n = 57)	
		%	%	%
	1 – 3	31.8	29.8	61.6
	4 – 6	7.9	12.6	20.5
	> 6	5.7	6.1	11.8
Household annual income (TShs.)	< 100 000	2.6	1.8	4.4
	100 000 -500 000	38.9	43.6	82.5
	501 000-1 000 000	8.3	4.4	12.7
	> 1 000 000	0.0	0.4	0.4

As indicated by the results in Table 1 the main income sources were selling crop products and livestock, mentioned by 55% of the respondents. Others included off-farm activities, monthly salaries and wages which comprised of 38.9%, 5.7% and 0.4% of the respondents respectively. The off-farm activities mentioned were carpentry, masonry, tailoring and salaried employments which were reported to include primary school teaching as well as small business. Small businesses included running small retail shops, buying and selling grains, fruits and vegetables as well as selling local brew. However, some of the off-farm activities contributed to environmental degradation which in turn led to climate change and its effects on food security at large. In line with this, it was found that selling of charcoal and firewood was one of the reported off-farm activities,

The results in Table 1 also show that 82.5% had annual income ranging from 100 000 to 500 000 TZS, 15.3% of the respondents had income from 501 000 to 1, 000, 000 TZS, and 3.9% had income below 100 000 Tanzanian Shillings while 0.9% of the households had annual income above 1 million Tanzanian Shillings.

Considering farm size, the results in Table 1 show that 61.6% of the respondents had farm size of between one and three hectares while only 6.1% of the respondents had farm size of less than one hectare. Farm size is one of the good indicators of wealth for farming households and a common studied variable in the adoption of new technology (Etwire *et al.,* 2013; Awotide *et al.,* 2014).

3.2 Influence of Socio-economic Factors on Adoption of Climate Change Adaptations

In determining the probability of the use or non-use of particular climate change adaptation strategy based on a set of socio-economic factors using binary logistic model starts with descriptive statistics which involved analysis of frequency and cross-tabulation with chi-square test to explore the association between each dependent variable and the set of independent variables. Only the independent variables that were found to be statistically significant associated with the dependent variables were subjected to the binary logistic model for prediction purposes

Table 2: Chi-square test showing association between dependents and independent variables

Dependent variables		**Independent variables**					
		Sex	**Age**	**Education level**	**Household income**	**Household size**	**Farm size**
Improved seeds	χ^2	1.860	10.82	20.79	2.170	4.610	25.04
	p- vale	0.173	0.004	0.000	0.537	0.100	0.000
Fertilizers	χ^2	6.970	1.880	2.450	6.390	6.404	21.78
	p- value	0.008	0.392	0.484	0.094	0.041	0.000
Inter-cropping	χ^2	0.290	5.210	1.750	7.190	4.830	17.61
	p- value	0.586	0.074	0.626	0.066	0.089	0.001
Rain water harvesting	χ^2	20.10	5.540	0.980	4.210	3.510	9.580
	p- value	0.000	0.063	0.805	0.240	0.172	0.048

The results in Table 2 show some of the independent variables, including farm size, household size, age, sex and education level of the head of the household had significant association with respective use of climate change adaptation strategies. Only those independent variables that were found to be statistically significant associated with the dependent variables after being tested using chi-square were subjected to the binary logistic model. On the other hand, household income was found to be not statistically significant associated with the use of climate change adaptation strategies at five per cent (5%) level of significance and was removed from further analysis in binary logistic regression model.

Table 3: Binary logistic regression analysis of the households' use of improved seed

Socio-economic factors	**Factors categories**		**ß**	**P – value**	**Exp(ß)**
Age	30 -50 years	Reference category*		0	0
	Below 30 years		0.249	0.605	1.283
	Above 50 years		20.709	0.999	9.858
Education level	Standard 7	Reference category*		0	0
	No formal school		-1.846	0.143	0.158
	Standard 4		-.466	0.696	0.628
	Secondary school and above		-1.749	0.168	0.174
Farm size	1 – 3 hectares	Reference category*		0	0
	Below 1 hectare		-3.082	0.004	0.046
	4-6 hectares		-3.936	0.001	0.020
	Above 6 hectares		-1.853	0.103	0.157

* The reference category is automatically estimated to be zero

With respect to the use of improved seeds, the results in Table 3 indicates that the effect of farm size less than one hectare on the chances of a household to use improved seed as climate change adaptation strategy was statistically significant, p = 0.004 while the effect of farm size ranging from four to six hectares was statistically significant, p = 0.001.This reveals that farm size of the household was statistically a significant determining factor for the households to use improved seeds as climate change adaptation strategy.

The odds ratio of the household whose farm size was less than one hectare was 1/0.046 while those with farm size ranging from four to six hectares was 1/0.20 times less likely to use improved seed as a strategy to adapt to climate change with respect to a reference category which was the households possessing one to three hectares. This finding depicts that households with a large farm size were less likely to use improved seeds strategy to adapt to climate change. The result reveals that household farm size of the two above mentioned categories was negatively related with the household’s use of improved seed as adaptation strategy to reduce the effect of climate change. This implies a unit increase of household farm size decreases the probability of the household to use improved seed as adaptation strategy by -3.936 and -3.082 for farm size ranges between four to six hectares and for farm size less than one hectare respectively.

Table 4: Binary logistic regression analysis of the households' use of fertilizers

Socio-economic factors	**Factors categories**	**ß**	**P – value**	**Exp(ß)**
Sex	Male	Reference category*	0	0
	Female	0.706	0.018	2.027
Household size	4 – 6 people	Reference category*	0	0
	Less than 4 people	0.274	0.576	1.316
	7and above	-0.697	0.032	0.498
Farm size	1 – 3 hectares	Reference category*	0	0
	Below 1 hectare	1.489	0.002	4.433
	4-6 hectares	1.919	0.012	6.812
	Above 6 hectares	0.471	0.394	1.601

*The reference category is automatically estimated to be zero

Considering the use of fertilizers, the results in Table 4 indicate that sex of household head being female, household size of seven and above people as well as farm size of four to six hectares and farm size less than one hectare were found to have statistically significant effect on the chances of a household using fertilizers as a climate change adaptation strategy at $p = 0.018$,$p = 0.032$, $p = 0.012$ and $p = 0.002$ respectively. This reveals that sex of the household head; household size and farm size were statistically significant determinant

The odds ratio for the household headed by female was 2.027 times more likely to use fertilizers as a strategy to adapt to climate change as opposed to those households headed by male which is a reference category. The odds ratio for the household with seven and above members was 1/0.489 times less likely to use fertilizers as climate change adaptation strategy as opposed to households with four to six members which was the reference category. Likewise, the odds ratio for the household whose farm size was less than one hectare and those with farm size of four to six hectares was 4.758 and 7.216 respectively times more likely to use fertilizers as adaptation strategy to climate change as opposed to the reference category which was the households possessing one to three hectares. Also, a unit increase of a household farm size increases the probability of the household to use fertilizer as adaptation strategy by 1.919 for farm size range between four to six hectares. Similarly, it changes by 1.489 for farm size less than one hectare.

Table 5: Binary logistic regression analysis of the households' use of intercropping

Socio-economic factors	Factors categories		ß	P – value	Exp(ß)
Age	30 -50 years	Reference category*		0	0
	Below 30 years		-0.841	0.045	0.431
	Above 50 years		0.406	0.674	1.501
Household size	4 – 6 people	Reference category*		0	0
	Less than 4 people		-0.035	0.945	0.965
	7and above		0.572	0.080	1.773
Farm size	1 – 3 hectares	Reference category*		0	0
	Below 1 hectare		-1.608	0.001	0.200
	4-6 hectares		-1.888	0.014	0.151
	Above 6 hectares		-0.645	0.224	0.524

*The reference category is automatically estimated to be zero

The results in Table 5 indicated that age category of the household head below 30 years, farm size categories of less than one hectare and four to six hectares had statistically significant effect on the chances of a household using intercropping as a climate change adaptation strategy p = 0. 045, p = 0.001 and p = 0.014 respectively. This reveals that age of the household head and farm size of the household were statistically significant determinant factors for the households' use of intercropping as a climate change adaptation strategy.

The odd ratio for the households whose head had age below 30 years was 1/0.431 times less likely to use intercropping as a strategy to adapt to climate change as compared to reference category which is the households possessing one to three hectares farm size. The odd ratio for the households whose farm size is less than one hectare and those with farm size of four to six hectares was 1/0.151 and 1/0.2 respectively times less likely to use intercropping as a strategy of adapting to climate change as opposed to reference category which is the households possessing one to three hectares. This finding depicts that the farm size has the probability of decreasing the chances of using intercropping as a strategy to adapt to the climate change.

It was also found that household heads with age below 30 years and household farm size of the two above mentioned categories are negatively related with the household's use of intercropping as adaptation strategy to climate change. This implies, while a unit increase of household heads with age below 30 years decreases the probability of the household to use intercropping by -0.841, the household farm size decreases the probability by -1.608 and -1.888 for farm size range between four to six hectares and for farm size less than one hectare respectively.

Table 6: Binary logistic regression analysis of the households' use of on-farm rain water harvest

Socio-economic factors	**Factors categories**		**ß**	**P – value**	**Exp(ß)**
Sex	Male	Reference category*		0	0
	Female		-1.398	<0.0001	0.290
Age	30 -50 years	Reference category*		0	0
	Below 30 years		1.258	0.005	3.519
	Above 50 years		0.041	0.973	1.042
Farm size	1 – 3 hectares	Reference category*		0	0
	Below 1 hectare		0.882	0.067	2.417
	4-6 hectares		0.402	0.602	1.495
	Above 6 hectares		0.295	0.596	1.343

*The reference category is automatically estimated to be zero

In the case of on-farm rain water harvest, the results in Table 6 indicate that sex of the household head being female, and age of the household head belonged to below 30 years age category had statistically significant effect on the chances of a household using rain water harvest as a strategy to adapt to climate change $p < 0.0001$ and $p = 0.005$ respectively. This reveals that sex and age of the household head were statistically significant determinant factors for the households to use on-farm rain water harvesting as climate change adaptation strategy

The odds ratio for the female headed household using rain water harvest as adaptation strategy against effects of climate change was 1/0.29 times less likely, compared to a reference category which is the male headed households. On the other hand, the odd ratio for the household head belonged to the age group of less than 30 years in using rain water harvest was 3.519 times more likely as opposed to reference category which was household heads with age category of 30 to 50 years old. A unit increase of a household headed by female decrease the probability of using rain water harvest strategy to adapt to climate change by -1.398 while a unit increase of the household head belonging to age category less than 30 years increase the probability by 1.258 respectively.

4.0 Conclusion and Recommendations

The paper analyzed the influence of household socio-economic factors on adoption of climate change adaptation strategies. From the analysis it was concluded that small farming households use various adaptation strategies, including the use of improved seeds, fertilizers, intercropping and on-farm rain water harvesting in response to climate change effects. There was association between the socio-economic factors such as farm size, household size, age, sex and education level of the household heads and the adaptation strategies. Age of the household head, household size and farm size are important determinant factors for the households' decision to use improved seeds, fertilizers, intercropping and on-farm rain water harvest as climate change adaptation strategies. These factors have the potential influence on the probability of using climate change adaptation strategies by the small farming households.

The paper recommends that various socio-economic factors should be considered when planning for intervention or advocating for the use of climate change adaptation strategies to improve small farming households' crop production. Different strategies including the mass media, government and private agricultural extension service agencies, different political forum and the artists should be used to sensitise people to use various adaptation strategies including improved seeds, fertilizers, intercropping and on-farm rain water harvest to cope with climate change related impacts. It is also recommended that village governments should establish climate change committee which will be responsible for documenting the climate change effects and in collaboration with researchers suggest effective adaption strategies to address the problem in specific areas.

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