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Determinants of Adaptation to Climate Change: A Gendered Analysis from Bahi and Kondoa Districts, Dodoma Region, Tanzania

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Abstract

Although various long term adaptation measures are currently implemented by farmers to adapt to the effects of climate change in Tanzania, information regarding factors determining choice of adaptation options between men and women is scarce. A gendered analysis was done to analyze determinants of adaptation to climate change in Bahi and Kondoa Districts, Dodoma Region, Tanzania. A cross-sectional research design was adopted whereby the data was collected from a sample of 360 respondents, 12 focus groups and 18 key informants. Analysis of quantitative data involved descriptive statistics and multinomial logit model using Nlogit 3.0 and qualitative data were summarized by using content analysis. Results revealed that the main occupation and land size were the main factors that determined adaptation options for men during food shortage while for women, the main factor was marital status. The village/location of respondents was the main factor that determined climate change adaptation option for women to adapt crops to climate change whereas, for men, access to agricultural knowledge was the main factor that encouraged men to use improved seeds, manure and deep cultivation, instead of selecting and keeping enough seeds for the next season. It is concluded that factors determining choice of climate change adaptation between men and women are not the same, emphasizing the need for gender differentiated interventions to promote climate change adaptation. Thus, planners and policy makers from Agriculture, Livestock and Environment sectors; Tanzania NAPA and other development practitioners dealing with climate change should use gender sensitive interventions to manage climate change.

Keywords: climate change, adaptation determinants, men, women

1. Introduction

Climate is changing and has affected many natural environments in all continents, most of the oceans, income groups and men and women differently (Intergovernmental Panel on Climate Change [IPCC], 2007a; Pielke, Prins, Rayner and Sarewitz, 2007). The poor, especially in developing countries, are among groups more vulnerable to climate change. Their vulnerability is due to low adaptive capacities, wide spread poverty and dependence on agricultural activities, activities more sensitive to climate change (Reser and Swim, 2010; IPCC, 2007a). Climate change is affecting food and water resources, which are critical for livelihoods in Africa.

In Tanzania drought, floods, soil erosion and health problems have increased and are affecting agricultural productivity, food security, water supply and human wellbeing (Fosu-Mensah, Vlek and Manschadi, 2010; Hassan and Nhemachena, 2008; IPCC, 2007a; Yanda, Kangalawe and Sigalla, 2006). Dodoma Region, which is located in a semi-arid area of Tanzania, is among the regions severely affected by failing agriculture due to climate change (United Republic of Tanzania [URT], 2007). Although all smallholder farmers in Dodoma Region will be affected by climate change, women are expected to be severely affected because, in addition to extreme poverty and low adaptive capacity, they make up a large number of individuals (63% in Tanzania) working in agricultural production (Swai, Mbwambo and Magayane, 2012; URT, 2007).

It is shown in the literature that men and women have survived and coped with a degree of uncertainty in relation to local weather in various ways over time (United Nations Development Programme [UNDP], 2009; Odjugo, 2010). However, most of the measures used were the short term adaptation practices, which are no longer efficient measures to rely on as climate change increases. Thus, climate change literature have shown that various long term adaptation measures are currently implemented by farmers to adapt to the effects of climate change in most African countries including Tanzania. Some of those measures include use of improved seeds, staggered planting and use of drought tolerant crop varieties (Mutekwa, 2009; Ishaya and Abaje, 2008).

Although various long term adaptation measures are currently implemented by farmers to adapt to the effects of climate change, adaptation options implemented by farmers are determined by diverse factors that vary among regions and individuals including men and women. The variation is due to significant differences that exist in traditions, resources and climates (Mbwambo, Mwatawala and Mngale 2011; Leary, Adejuwon, Barros, Burton, Kulkarni and Lasco, 2008). It is thus important to understand factors determining choice of climate change adaptation options among various groups including men and women in order for policy makers to consider such variations when developing interventions to manage climate change. Studies for example by Enujeke and Ofuoku (2012), Nabikolo, Bashaasha, Mangheni and Majaliwa (2012), Mbwambo *et al*. (2011) and Hassan and Nhemachena (2008), have reported some of the factors determining farmers' choice of climate change adaptation options. The reported factors include land size, access to extension, credit and market services. Nevertheless, reported factors are not disaggregated by gender to realize factors influencing choice of climate change adaptation options between men and women.

Failure to consider gender and/or disaggregate factors influencing the choice of climate change adaptation options between men and women is among the main constraints for the policy makers dealing with climate change to develop effective policies relevant to manage climate change (United Nations Population Fund [UNFPA], 2009; Deressa, Hassan, Alemu, Yesuf and Ringler, 2009; Lambrou and Piana, 2006). According to UNFPA (2009) and UNDP (2009), for a policy that is intended to address any aspect of climate change to be effective, the differences between men and women must be taken into account during policy formulation. Gender blind policies may aggravate the problems associated with climate change by widening inequalities between the sexes. This paper, therefore, presents some of the findings intended to fill part of this information gap from a field study done to analyze factors influencing adaptation decisions between men and women in Bahi and Kondoa districts, Dodoma Region Tanzania.

Though climate change may have various definitions depending on the way it is perceived locally this study adopted the IPCC definition of climate change that refers to a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer (IPCC, 2007b). It is a long-term continuous change (increase or decrease) to average weather conditions (e.g. average temperature) or the range of weather (e.g. more frequent and severe extreme storms) (Dinse, 2011). Climate change may be due to natural internal processes or external forces or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2007b).

2. Methodology

2.1 Study Area

The study was conducted in three villages of Bahi District, Dodoma Region, namely Nagulobahi, Chipanga B and Msisi; and three villages of Kondoa District that is Puhi, Isusumya and Kurio. Administratively Bahi District has four divisions, 21 wards and 56 villages whereas Kondoa District has eight divisions, 35 wards and 160 villages. Both Districts are situated in semi-arid areas and have a dry savannah type of climate which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. Bahi District has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6^{0}C. Kondoa District has an annual average rainfall of about 500 to 800 mm and an annual temperature of about 21^{0}C. The economies of Bahi and Kondoa Districts depend on agriculture (crops and livestock production). The main crops grown in Bahi District are pearl millet, sorghum, paddy and ground nuts; and for Kondoa District the main crops are maize, finger millet, oil seeds, pearl millet and sorghum (URT, 2003).

2.2 Research Design and Study Population

A cross-sectional research design was used in this study. The design is useful for descriptive purposes, as well as determination of relationships between and among variables and allows the use of other methods of data collection such as observations (Kothari, 2004). The population of the study was farmers dealing with crop farming and livestock keeping in the study area; and the list of all farmers dealing with crops and livestock production formed a sampling frame from which two strata, one of men and the other of women were chosen. A sampling unit was a man or a woman farmer.

2.3 Sampling and Sample Size

Sampling techniques involved purposive sampling, stratified and simple random sampling. Purposive sampling was used to select Bahi and Kondoa districts, three divisions from each district, one ward from each division and one village from each ward. Reasons for the selection of the two districts were that the selected area is in a semi-arid, the area more vulnerable to climate change due to prominent and persistent variation in rainfall, temperature and drought; and the area where climate change evidence is expected to be more apparent (Food and Agricultural Organization [FAO], 2008; IPCC, 2007a); also another reason that prompted the researcher to select the study area was a need to capture local knowledge about climate change from diverse cultural perspectives (that is from *Warangi, Wagogo, Wanyambwa* and *Wasandawe*). The selection of wards and villages was based on the areas that were far from the ward centre/town where crop farmers and livestock keepers resided and where limited (or no) research, especially on climate change, having been conducted to avoid duplication of efforts. After selecting the villages, Yamane (1967) formula was used to get sample of 360 respondents from the population of the study. Yamane (1967) provides a table that indicates population size and an appropriate sample size to be drown from indicated population, using a simplified formula, that is:

$$n = N/1 + N(e)^2 \quad (1)$$

Where: n = the sample size

N = the population size

e = the level of precision (an error of five percent).

Since the study was focused on gender, the sampling frame was put into two strata of men and women using this formula:

$$n_h/n = N_h/N \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$n_h = n(N_h/N) = nW_h$$

Where:

n_h = sub-sample

n = desired sample

N_h = sub-sampling frame/population

N = Sampling frame (population)

W_h = sample proportion

That is, sub-sample 1 (men) = $n_h/360 = 2139/4498$

$n_h = 360(2139/4498) = 360(0.4755) = 171.2$

n_h per village 171.2/6 = 29

Sub-sample 2 (women) = $n_h/360 = 2359/4498$

$n_h = 360(2359/4498) = 360(0.52445) = 188.8$

n_h per village 188.8/6 = 31

The two sub-samples were 29 men and 31 women per village (Ahmed, 2009; Kothari, 2004). However, from the two strata, a simple random sampling technique was employed to select 30 men and 30 women per village in order to facilitate a fair discussion where comparison between men and women per village was necessary (Kothari, 2004).

2.4 Type of Data, Data Collection Methods and Tools for Data Collection

Both primary and secondary data were collected. Primary data involved qualitative and quantitative data. Methods to collect qualitative data were key informant interviews and focus group discussions; and a structured questionnaire was used to collect quantitative data. To collect qualitative data, a checklist of items for in-depth interviews with key informants was used to gather information from 18 key informants; and a focus group interview guide was used in discussion to gather information from 12 focus groups (one for men and another for women from each village). To collect quantitative data, a structured questionnaire was administered to a sample of 360 respondents to verify and quantify some of the findings from qualitative data.

2.5 Data Analysis

Analysis of qualitative data involved content analysis in which the data were broken down into smallest meaningful units of information and/or themes and summarized to supplement important information with respect to the objectives of the study. Quantitative data analysis was based mainly on descriptive statistics including frequencies, means and percentages. A multinomial logit model was used to analyze factors determining choice of climate change adaptation options between men and women using Nlogit 3.0.

Multinomial logit model and multinomial probit model are commonly used in adoption decision studies involving multiple choices. The models are important in analyzing adaptation decision of farmers and they are appropriate for evaluating alternative combinations of adaptation options (Mbwambo *et al.,* 2011; Hassan and Nhemachena, 2008). However, this study used a multinomial logit model to investigate factors determining choice of climate change adaptation options between men and women because the model is easier to compute (Mbwambo *et al.,* 2011; Hassan and Nhemachena, 2008). It is assumed from the study that each respondent faces a set of discrete, mutually exclusive choices of adaptation options, which are assumed to depend on socio-economic, cultural and demographic factors X. The multinomial logit model for the choice of adaptation option specifies the following relationship between the probability of choosing adaptation option A_i and the set of independent variables X as (Greene, 2003):

$$Prob(Ai = j) = \frac{e^{\beta'_j x_i}}{\sum_{k=0}^{j} e^{\beta'_j x_i}}\ , j = 0,1 \ldots j \tag{3}$$

Where βj is a vector of a coefficient on each of the dependent variables X. Equation (3) can be normalized to remove indeterminacy in the model by assuming that β_0 = 0 and the probabilities can be estimated as:

$$Prob(A = j|x_i) = \frac{e^{\beta'_j x_i}}{1+\sum_{k=0}^{j} e^{\beta'_j x_i}}, j = 0,1 \ldots . j \tag{4}$$

Estimating equation (4) yields the J log odds ratios

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = x'_i\,(\beta_i - \beta_k) = x'_i\beta_j, \text{ if } k = 0 \tag{5}$$

The dependent variable is, therefore, the log of one alternative relative to the base alternative. The Multinomial Logistic regression coefficients are difficult to interpret, and associating β_j with the j^{th}outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as (Greene, 2003):

$$\delta_j = \frac{\delta P_j}{\delta x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k\beta_k\right] = P_j\left(\beta_j - \bar{\beta}\right) \tag{6}$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Greene, 2003). The signs of the marginal effects and respective coefficients may be different as the former depend on the sign and magnitude of all other coefficients.

2.6 The Dependent and Independent Variables Used in the Model

The dependent variable used in the model was gender specific adaptation practices to climate change (Table 1). The variable consisted of various adaptation options practiced by the majority of respondents in the study area, which fell into three groups: (i) adaptation options implemented to reduce food shortage or hunger, (ii) adaptation options implemented to reduce effects of climate change on crops, and (iii) adaptation options implemented to reduce effects of climate change on land and/or environment. The independent variables used in the empirical analysis were: household size, experience of respondent in crops production (years) and the land size (hectares) owned by respondents (Table 2).

Table 1. Adaptation options practiced by the majority of respondents by sex

Adaptation practices	Men (n=180)		Women (n=180)	
	n	%	n	%
Adaptation practices to adapt to/reduce food shortage or hunger				
Reduce number of meals per day	37	20.6	48	26.7
Sell labour	35	19.4	44	24.4
Sell livestock and/or local chicken	49	27.2	24	13.3
Engage in non-farm production activities	29	16.1	38	21.1
Plant hunger buffering crops	30	16.7	26	14.4
Adaptation practices to adapt/reduce climate change for crops				
Select and keep enough seeds for the next season	41	22.8	76	42.2
Use of deep cultivation	39	21.7	29	16.1
Use of improved seeds	37	20.6	25	13.9
Use of manure	34	18.9	29	16.1
Change of crop varieties	29	16.1	21	11.7
Adaptation practices to adapt/reduce climate change for land and/or environment				
Avoid cultivating along steep slopes	50	27.8	55	30.6
Plant trees	48	26.7	40	22.2
Contours/plant reeds	44	24.4	35	19.4
Use of ridge farming	38	21.1	50	27.8

Table 2. Independent variables used in the empirical analysis

Respondent characteristics	Mean	
	Men (n=180)	Women (n= 180)
	%	%
Household size	7.22	5.56
Experience in crops production (years)	34.51	31.63
Land size (hectares) owned by respondents	3.8	1.9

Other independent variables used in the empirical analysis were village of respondents/location, access to agricultural knowledge, credit, land ownership, access to education, main occupation undertaken by respondent, ethnic group and marital status (see Appendix 1).

3. Results and Discussions

3.1 Factors Determining Choice of Adaptation Options to Reduce Food Shortage/Hunger by Sex

Table 3 shows marginal effects and ρ-levels for choice of adaptation options between men and women during food shortage or hunger from the multinomial logit model. The reference category regarded as a base ($Y = 0$) from which men and women were expected to move to other adaptation options in this analysis was adaptation option ‘reduce number of meals per day’. Other adaptation options were sell labour ($Y = 1$), sell livestock and/or local chicken ($Y = 2$), engage in non-farm production activities ($Y = 3$) and plant hunger buffering crops ($Y = 4$).

It is revealed in Table 3 that some of explanatory variables were statistically significant at 5% level and the chi-square result shows that the likelihood ratio statistic was significant at $\rho \leq 0.01$ for both men and women. (The estimated coefficients are given in Appendix 2). The second column in Table 4 compares the choice of adaptation option ‘sell labour’ with ‘reduce the number of meals per day’. Marginal effects and their signs reflect the expected change in the probability of choosing to sell labour as opposed to reducing the number of meals per day per unit change in the explanatory variable. This explanation applies to other remaining choices in Table 3.

Table 3. Factors determining choice of adaptation options to reduce food shortage or hunger by sex (Marginal effects)

Variable	**Marginal effect**							
	Men (n=180)				**Women (n=180)**			
	Y = 1	**Y = 2**	**Y = 3**	**Y = 4**	**Y = 1**	**Y = 2**	**Y = 3**	**Y = 4**
Ethnic groups	- 0.002	- 0.005	0.0232	- 0.012	0.014	0.027	- 0.06**	0.03
Marital status	- 0.210	- 0.115	0.0113	- 0.057	0.141**	0.013	0.001	- 0.13**
Main occupation	0.18**	- 0.082	- 0.0029	- 0.001	0.057	-0.039	- 0.002	- 0.04
Household size	- 0.02	0.012	- 0.0002	- 0.19**	-	-	-	-
Education	0.002	0.067	0.1392	- 0.057	-	-	-	-
Land size	0.005	- 0.008	0.0006	0.008**	0.01	- 0.003	0.005	- 0.02**
Experience in crop production	- 0.003	0.004	- 0.011**	0.006**	- 0.01**	0.0003	0.001	0.01**
Log likelihood function				- 265.4093				-270.949
Restricted log likelihood				- 286.3044				-283.198
Chi squared				41.79020				24.49875
Prob[ChiSqd > value]				0.1362045E-01				0.7916311E-01
Pseudo R-squared				0.07298				0.04325

It is depicted in Table 3 that a unit change in the main occupation undertaken by respondents significantly (5%) increased the decision of men to sell labour; a unit change in the land size and experience in crop production, significantly (5% each) increased their decision to plant hunger buffering crops, but experience in crop production, significantly (5%) reduced the decision of men to engage in non-farm production activities; while a unit change in the household size significantly (5%) reduced the decision of men to plant hunger buffering crops, instead of reducing the number of meals per day. Thus, from the findings it is revealed that the main occupation, land size and experience in crop production were the main factors that positively and significantly determined the choice of adaptation options for men during food shortage or hunger, encouraging them to sell labour and plant hunger buffering crops (that is cassava and sweet potatoes) instead of reducing the number of meals per day.

Although experience in crop production encouraged men to plant hunger buffering crops to adapt to food shortage, the same variable discouraged them from engaging in non-farm production activities, while household size discouraged men from planting hunger buffering crops thus, causing the majority of men with larger households to remain with only one adaptation option (selling labour). This can be explained by the fact that food shortage or hunger occurred when production especially of crops failed mainly due to drought or floods. During such periods farmers were forced to search for other alternatives for them to survive. In the study area the main production activities were agro-pastoral and crop production of which, men were mainly agro-pastorals (78.9% of men 50% of women).

Farmers were also engaged in non-farm production activities whereby men dealt mainly with fishing, charcoal and livestock businesses and women were undertaking local beer business, petty trade, salt and pottery businesses. Most of the non-farm production activities also failed during drought because they depended on rain. As the non-farm production activities failed, farmers were forced to engage in selling labour. Although majority of farmers planted hunger buffering crops, as drought persisted, all crops were damaged by drought. This indicates further that measures to increase production and maintain sustainability of production activities in the study area are vital for farmers to adapt to food shortage or hunger, as climate change increases.

In the case of women, it is shown in Table 3 that a unit change in marital status, significantly (5%) increased the decision of women to sell labour, but significantly (5%) discouraged them from planting hunger buffering crops. A unit change in experience of respondent in crop production, significantly (5%) increased decision of women to plant hunger buffering crops, but significantly (5%) reduced their decision to sell labour. A unit change in land size, significantly (5%) reduced the decision of women to plant hunger buffering crops, while a unit change in ethnic group of respondents significantly (5%) reduced decision of women to engage in non-farm production activities. The results mean that the main factors that determined the choice of adaptation options among women during food shortage or hunger were marital status and experience of respondents in crop production. Marital status and experience of respondents in crop production encouraged women to sell labour and plant hunger buffering crops respectively.

The findings have shown that the land size encouraged men, but discouraged women from planting hunger buffering crops to adapt to food shortage or hunger. It is shown in Table 2 that the average land size owned by men in the study area was 3.8 hectares while on average women owned 1.9 hectares. Since the land size of women was small, they had to give priority to food crops, but the size of land of men enabled them to plant additional crops including the hunger buffering crops, meaning that small farms was among the factors that hindered adaptation effort, especially for women in the study area. The experience of respondents in crop production also positively and significantly influenced the choice of adaptation options for men and women, suggesting that more experienced farmers were more likely to adapt to climate change than less experienced ones. The observation concurred with the findings of Hassan and Nhemachena (2008), who asserted that experienced farmers have better knowledge on agronomic practices that can be used to adapt to the changes in climate.

3.2 Factors Determining Choice of Adaptation Options to Reduce Effects of Climate Change to Crops by Sex

The marginal effects and ρ-levels for the choice of adaptation options for men and women to adapt crops to climate change from the multinomial logit model are shown in Table 4. A reference category regarded as a base (Y = 0) from which men and women were expected to move to other adaptation options was 'select and keep enough seeds for the next season'. Other adaptation options were: use of deep cultivation (Y = 1), use of improved seeds (Y = 2), use of manure (Y = 3) and change of crop varieties (Y = 4). The findings in Table 5 show that some of the explanatory variables were statistically significant at 5% level and the chi-square test results show that the likelihood ratio statistic was significant at $\rho \leq 0.01$ for both men and women. (The estimated coefficients are given in Appendix 3). The second column in Table 5 compares the choice of adaptation option of 'use of deep cultivation' with 'select and keep enough seeds for the next season'. The marginal effects and their signs reflect the expected change in the probability of choosing to use deep cultivation as opposed to selecting and keeping enough seeds per unit change in the explanatory variable. This explanation applies to other remaining choices in Table 4.

Table 4. Factors determining choice of adaptation options to reduce effects of climate change to crops by sex (Marginal effects)

Variable	**Marginal effect**							
	Men (n=180)				**Women (n=180)**			
	Y = 1	**Y = 2**	**Y = 3**	**Y = 4**	**Y = 1**	**Y = 2**	**Y = 3**	**Y = 4**
Village/location of respondents	0.029	0.049**	0.04**	-0.04**	0.028	0.001	-0.041**	0.03**
Access to agricultural knowledge	0.12**	0.0001	-0.113	0.007	0.025	0.001	- 0.043	- 0.036
Access to credit	-0 .03	- 0.04	- 0.07	0.016	0.115	-0.051	0.074	0.054
Land size	- 0.001	- 0.005	0.003	0.0006	0.004	- 0.004	0.0001	- 0.002
Experience in crop production	- 0.005	0.001	0.001	0.0004	- 0.003	0.002	0.003	0.002
Education	- 0.061	0.069	- 0.03	0.006	-	-	-	-
Land ownership	0.063	- 0.109	0.051	0.025	- 0.185**	- 0.015	- 0.04	- 0.14**
Log likelihood function				- 268.1363				- 251.2854
Restricted log likelihood				- 288.4451				- 265.8865
Chi squared				40.61756				29.20207
Prob[ChiSqd > value]				0.1833942E-01				0. 8385619E-01
Pseudo R-squared				0.07041				0.05491

Table 4 shows that a unit change in the village/location of respondents, significantly (5%) increased the decision of men to use improved seeds and manure respectively, but significantly (5%) reduced their decision to change crop varieties to adapt crops to climate change, instead of selecting and keeping enough seeds for the next season. Moreover, a unit change in respondents' access to agricultural knowledge, significantly (5%) increased the decision of men to use deep cultivation instead of selecting and keeping enough seeds for the next season. Hence, the village/location of respondents and access to agricultural knowledge were the main factors that positively and significantly determined the choice of adaptation options for men to reduce effects of climate change on crops, encouraging them to use improved seeds, manure and deep cultivation, instead of selecting and keeping enough seeds for the next season. The observation concurred with the findings of other studies including Enujeke and Ofuoku (2012) and Hassan and Nhemachena (2008), who found that access to crop and livestock extension services, significantly increases the likelihood of adaptation.

Table 4 further shows that a unit change in the village/location of respondents significantly (5%) increased the decision of women to change crop varieties, but significantly (5%) reduced their decision to use manure, while a unit change in the land ownership, significantly (5%) reduced the decision of women to use deep cultivation and change crop varieties respectively instead of selecting and keeping enough seeds for the next season. According to the findings, the village/location of respondents was the main factor that determined choice of climate change adaptation options for women to reduce effects of climate change to crops, encouraging them to change crop varieties instead of selecting and keeping enough seeds for the next season.

However, land ownership of respondent had no significant influence on the decision of men to reduce effects of climate change on crops, indicating that the choice of adaptation option for men depended on other factors rather than land. In the case of women those who had land were likely to adapt crops to climate change compared to those who had no land, meaning that promotion of land ownership for women in the study area would increase their adaptation efforts. The findings were in line with the study of Nabikolo *et al*. (2012) who found that the land ownership had negative influence on adaptation to climate change for men headed household.

The findings also revealed that the village/location of respondents discouraged women from using manure on their farms, but encouraged men to use manure and improved seeds. The revealed variation could be due to the fact that men were the main agro-pastoralists (78.9% of men 50% of women), keeping livestock, and they were in a better position to access manure compared to women. It was also revealed during focus group discussions that men managed to buy and/or hire other technologies including tractors, wheel barrows and power tillers to ferry manure to their farms. Moreover, using manure and improved seeds were among the by-laws in the study area. Village leaders distributed improved seeds especially of sorghum, pearl millet, maize, sunflower and cowpeas crops to the farmers, but the seeds were inadequate and sometimes brought when the season was over. Men, the majority of whom were mobile and liquid financially compared to women, travelled to Kondoa, Bahi and Dodoma towns to buy improved seeds instead of relying on the small amount of seeds brought in their respective villages. This means that locating input markets in the village where women could easily access would improve efforts of women to adapt crops to climate change.

It is also indicated in Table 4 that access to credit had no significant influence on the choice of adaptation options for both men and women. The findings were contrary to the studies of Nabikolo *et al.* (2012), Derressa *et al.* (2009) and Gbetibouo (2009), which reveal that the availability of credits has positive and significant impact on adaptation to climate change, as access to credits increases financial resources of farmers, reduces cash constraints and allows farmers to purchase inputs including improved seeds. In the study area credit services were inadequate and only few respondents (12.8% of men and 11.1% of women) had access to credit. Men borrowed from the traditional credit (the rich men livestock keepers/*matajiri ng'ombe*) and women from the Savings and Credit Co-operative Societies (SACCOS). The loans borrowed were small and could not influence adaptation, indicating that the low access to credit discouraged adaptation to climate change. Thus, there is a need to facilitate farmers' access to credits in the study area in order to improve adaptation to climate change.

Furthermore, access to education had no significant influence on decision of men and women to adapt crops to climate change. The results were contrary to the studies of Enujeke and Ofuoku, (2012), Deressa *et al.* (2009) and Maddison (2006), which have shown that there is a positive relationship between the educational level of respondents and adaptation to climate change. In the study area 86.7% of men and 72.2% of women had access to education of which 83.3% of men and 69.4% of women had attained primary school education level. The observation indicates that the kind of knowledge acquired by men and women from primary school education could not influence adaptation to climate change, suggesting the subject of climate change to be introduced in the curriculum of primary school education to improve climate change awareness.

3.3 Factors Influencing Choice of Adaptation Options to Reduce Climate Change Effects to Land by Sex

The marginal effects and ρ-levels for the choice of adaption options for men and women to adapt land and/or environment to climate change from the multinomial logit model are shown in Table 5. In this analysis, adaptation option 'avoid cultivating along steep slopes' was a reference category considered to be a base (Y = 0) from which men and women were expected to move to other adaptation options including: 'plant trees' (Y = 1), 'make contours and/or plant reeds' (Y = 2) and use ridge farming (Y = 3). According to the findings in the Table, some of explanatory variables are statistically significant at the 5% and 1% levels and the chi-square result shows that likelihood ratio statistic was significant at $\rho \leq 0.001$ for both men and women. (The estimated coefficients are given in Appendix 4). The second column in Table 5 compares the choice of the adaptation option 'plant trees' with 'avoid cultivating along steep slopes'. The marginal effects and their signs reflect the expected change in the probability of choosing to plant trees as opposed to 'avoid cultivating along steep slopes' per unit change in the explanatory variable. This explanation applies to other remaining choices in Table 5.

It is shown in Table 5 that a unit change in the access to agricultural knowledge significantly (5%) increased the decision of men to plant trees and for women to use contours and/or plant reeds; the village/location of respondents positively and significantly (1%) determined choices of men and women to use contours and/or plant reeds to control soil erosion but significantly (1%) reduced their decisions to plant trees as opposed to avoid cultivating along steep slopes. In addition, a unit change in the level of education significantly (5%) reduced decisions of women to use contours and/or plant reeds but it had no significant influence on men; and a unit change in the experience of respondents in crop production significantly (1%) reduced decision of women to undertake ridge farming; while a unit change in the land ownership significantly (5%) increased decision of women to undertake ridge farming instead of avoiding cultivating along steep slopes. Access to education significantly reduced decision of women to use contours and/or plant reeds but it had no significant influence on men, showing that the knowledge gained from primary school was lacking the component of land use and/or environmental conservation, the defect that could be corrected by providing farmers with land use and/or environmental conservation knowledge.

Table 5. Marginal effects – decision to adapt land/environment to climate change by sex

Variable	**Marginal effect**					
	Men (n=180)			**Women (n=180)**		
	Y = 1	**Y = 2**	**Y = 3**	**Y = 1**	**Y = 2**	**Y = 3**
Access to agricultural knowledge	0.141**	- 0. 072	- 0.006	- 0. 073	0. 117**	0.075
Village of respondents	- 0.07***	0.095***	0.016	- 0. 06***	0.071***	- 0.035
Education	0.086	- 0.126	0.045	0.057	- 0.121**	- 0.005
Land size	- 0. 002	0.003	- 0.004	0. 001	0. 005	0.001
Experience in crop production	- 0. 001	0.002	0.00003	0.003	- 0.004	- 0. 02***
Land ownership	- 0.014	- 0.063	- 0.059	0.053	- 0.102	0.299**
Log likelihood function			- 228.2684			- 216.1859
Restricted log likelihood			- 248.5808			- 246.7354
Chi squared			40.62490			61.09903
Prob[ChiSqd > value]			0.3647104E-03			0.000000
Pseudo R-squared			0.08171			0.12381

Table 5 also shows that, a unit change in the experience of respondents in crop production significantly (1%) reduced decision of women to undertake ridge farming while a unit change in the land ownership significantly (5%) increased their decision to undertake ridge farming as opposed to avoid cultivating along steep slopes. Therefore, access to agricultural knowledge and the village/location of respondents were the main factors that positively and significantly determined the choice of adaptation options for men to reduce effects of climate change on land, encouraging them to plant trees and use contours and/or plant reeds to control soil erosion, while for women the land ownership, access to agricultural knowledge and village/location of respondents were the main factors that positively and significantly encouraged them to use contours and/or plant reeds and ridge farming to reduce effects of climate change on land and/or environment.

The village/location of respondents supporting adaptation to climate change effects could be explained by the fact that, the two districts of Bahi and Kondoa where the study villages were located that is Nagulobahi, Chipanga B and Msisi for Bahi District and Puhi, Isusumya and Kurio for Kondoa District, were not in the same altitude. The villages of Kondoa District were a bit in higher altitude compared to those of Bahi District and contours and/or reeds were practiced mainly at Kondoa District because of its location. In addition, Kurio and Puhi villages practiced ridge farming for the most of their crops, but in other villages especially of Bahi District ridge farming was mainly applied in sweet potatoes and cassava farms. Moreover, during key informants interviews and focus group discussions it was revealed that, farmers were not allowed to cut down trees unless for a genuine reason and after seeking permission from the village environmental committee members. There was also a culture to protect traditional trees, which farmers observed under their traditional leaders. For the farmers who cut down traditional trees the penalty was to pay a goat. Those village by-laws and/or regulations and traditions/culture encouraged adaptation to climate change in the study area.

4. Conclusions and Recommendations

This study has analyzed factors determining choice of climate change adaptation options between men and women by using a multinomial logit model. Dependent variables used in the model were: adaptation options implemented to adapt to food shortage or hunger, adaptation options implemented to adapt crops to climate change and adaptation options implemented to adapt land and/or environment to climate change. The dependent variable was regressed on the following independent variables: household size, experience of respondents in crops production and land size. Other independent variables were village/location of respondents, access to agricultural knowledge, access to credit, education, the main occupations undertaken by respondents, ethnic groups of respondent, land ownership and marital status.

The study has shown that the main factors that positively and significantly determined choice of climate change adaptation options between men and women were the main occupation, land size, experience of respondents in crop production, the village/location of respondents, access to agricultural knowledge, marital status and land ownership. The main occupation, land size, experience of respondents in crop production, the village/location of respondents and access to agricultural knowledge determined choice of climate change adaptation for men, whereas for women, the land ownership, marital status, experience of respondents in crop production, the village/location of respondents and access to agricultural knowledge were the main factors that determined their decision to adapt to climate change.

Although experience of respondents in crop production and village of respondents had effects on the choice of climate change adaptation for both men and women, in some cases their influence was different. For example, the village of respondents encouraged men to use improved seeds and manure respectively to adapt crops to climate change, but discouraged women from using manure and instead encouraged them to sell labour to adapt crops to climate change. The differences revealed in the factors influencing choice of climate change adaptation between men and women prove that factors determining choice of climate change adaptation between men and women are not the same, emphasizing the need for gender differentiated interventions to promote climate change adaptation. Therefore, there is a need for the Agricultural, Livestock and Environmental sectors; the NAPA, LGAs, NGOs and other development practitioners dealing with climate change to use gender sensitive interventions to manage climate change effects.

On the other hand, issues such as unequal land ownership between men and women, inadequate access to agricultural knowledge and credits; failure of village leaders/government to provide farmers with necessary inputs and services such as, improved seeds; and weak enforcement of village by-laws were among the factors that aggravated the variation in the choice of adaptation options between men and women. Thus, it is important for the LGA, NGOs, CBOs and other development practitioners to create awareness on the importance of women to own land; to make sure that inputs are provided to farmers on time; and ward and village leaders to make sure that by-laws and other regulations are implemented in the study area.

At the policy level, in order to promote adaptation to climate change it is important for the policymakers and planners including the Tanzania NAPA to introduce necessary measures to reduce inequality in land ownership between men and women; ensure allocation of crops and/or livestock extension agents at the village level to improve agricultural knowledge for both men and women; to facilitate the availability of and access to agriculture inputs at affordable price, credit services; and develop mechanism which will promote production and ensure sustainability of production activities in the study area. Policymakers and planners would also do well if they could develop measures to introduce the subject of climate change and environment conservation in the curriculum of primary school education to improve climate change and environment conservation awareness in the study area and in Tanzania.

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Appendixes

Appendix 1. Other independent variables used in the empirical analysis

Variables	Men (n=180)		Women (n=180)	
	n	**%**	**n**	**%**
The village of respondents or location				
Nagulobahi	30	16.7	30	16.7
Chipanga B	30	16.7	30	16.7
Msisi	30	16.7	30	16.7
Puhi	30	16.7	30	16.7
Isusumya	30	16.7	30	16.7
Kurio	30	16.7	30	16.7
Access to agricultural knowledge				
Crop/livestock extension agent	136	75.6	42	23.3
Fellow farmers/neighbours	26	14.4	102	56.7
None	18	10.0	36	20.0
Access to credit				
No	157	87.2	160	88.9
Yes	23	12.8	20	11.1
Credit institutions from which respondents borrowed				
Traditional credits	11	47.8	1	5.0
SACCOs	9	39.1	18	90.0
Others	3	13.1	1	5.0
Land ownership				
No	1	0.6	14	7.8
Yes	179	99.4	166	92.2
Access to education				
No	24	13.3	50	27.8
Yes	156	86.7	130	72.2
The main occupation undertaken by respondents				
Agro-pastoralists	142	78.9	90	50.0
Crop production	38	21.1	90	50.0
Ethnic group of respondents				
Gogo	66	36.7	63	35.0
Rangi	52	28.9	57	31.7
Sandawe	30	16.7	30	16.7
Nyambwa	20	11.1	21	11.7
Others	12	6.8	9	5.2
Marital status of respondents				
Married	177	98.3	122	67.8
Singles including divorced, widows, separated and widowers	3	1.7	58	32.2

Appendix 2. Factors influencing choice of adaptation options to food shortage or hunger by sex (estimated coefficients)

Variable	**Coefficient**							
	Men (n=180)				**Women (n=180)**			
	Y = 1	**Y = 2**	**Y = 3**	**Y = 4**	**Y = 1**	**Y = 2**	**Y = 3**	**Y = 4**
Factors influencing choice of adaptation options to adapt to food shortage or hunger by sex								
Ethnic group	0.004	- 0.021	0.097	- 0.066	0.10	0.16	- 0.44	0.27
Marital status	- 2.527	- 2.456	- 1.051	-1.824	0.66	0.16	0.11	- 0.89
Main occupation	1.354**	- 0.100	0.425	0.425	0.16	- 0.24	- 0.09	- 0.34
Household size	- 0.132	- 0.001	- 0.082	-0.207**	-	-	-	-
Education	0.722	1.146	1.203**	0.339	-	-	-	-
Land size	0.049	- 0.031	0.026	0.075**	- 0.02	- 0.05	0.001	- 0.17**
Experience in crop production	- 0.024	0.016	- 0.045	0.031	- 0.04	- 0.01	0.003	0.04

Appendix 3. Factors influencing choice of adaptation options to adapt crops to climate change by sex (estimated coefficients)

Variable	**Coefficient**							
	Men (n=180)				**Women (n=180)**			
	Y = 1	**Y = 2**	**Y = 3**	**Y = 4**	**Y = 1**	**Y = 2**	**Y = 3**	**Y = 4**
Factors influencing choice of adaptation options to adapt crops to climate change by sex								
Village of respondents	0. 49***	0. 60***	0. 61***	0 .11	0. 223	0. 048	- 0.235	0. 323**
Access to agricultural knowledge	0. 60	0. 068	- 0. 55	0.108	0.042	- 0.118	- 0.406	- 0.45
Access to credit	- 0 .673	- 0.756	- 0. 953	- 0.47	1.182	0. 10	0. 933	0.291
Land size	- 0. 011	- 0. 034	0. 010	- 0.005	0. 018	- 0. 035	- 0. 028	- 0. 883
Experience in crop production	- 0. 036	- 0. 005	- 0. 006	- 0.009	- 0. 007	0. 026	0. 024	0. 028
Education	- 0.362	0. 237	- 0.276	- 0. 056	-	-	-	-
Land ownership	0.424	- 0.376	0.422	0.295	- 2.068**	- 1.045	- 1.134	- 2.164**

Appendix 4. Factors influencing choice of adaptation options to adapt land and/or environment to climate change by sex (estimated coefficients)

Variable	Coefficient					
	Men (n=180)			Women (n=180)		
	Y = 1	Y = 2	Y = 3	Y = 1	Y = 2	Y = 3
Factors influencing choice of adaptation options to adapt land/environment to climate change by sex						
Access to agricultural knowledge	0.737	- 0.144	0.181	0.065	1.097**	0.64
Village of respondents	- 0.111	0.608***	0.215	- 0.30**	0.373**	- 0.188
Education	0.344	- 0.602	0.211	0.027	- 0.96**	- 0.232
Land size	- 0.017	0.006	- 0.026	0.028	0.053	0.025
Experience in crop production	- 0.004	0.008	0.0008	- 0.046	- 0.08**	- 0.12***
Land ownership	- 0.510	- 0.764	- 0.711	1.009	0.152	1.84***