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Analysing the Determinants of Adaptation Practices to Climate Variability among Tomato Farmers in the Offinso North District, Ghana

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Abstract:
Climate variability continues to impact on rural areas and adaptation strategies are new areas of study in rural communities in most developing countries including Ghana. The study therefore analyses the determinants of tomato farmers' choice of adaptation strategies in response to climate variability in the Offinso North District, Ghana, using a modeling approach. The study used primary data gathered through structured interviews sampled from a cross-section of registered tomato farmers in the District. The systematic sampling technique was used to sample 378 tomato farmers across three selected communities in the District. The study was analysed using both descriptive and econometric methods with the help of the IBM SPSS Statistics version 21. The multinomial logit regression model was used to determine tomato farmers' choice of adaptation strategies to climate variability. The results indicated that gender ($p<0.05$), age ($p<0.01$), marital status ($p<0.10$), educational status ($p<0.01$), access to credit ($p<0.05$), farm size ($p<0.01$), farming experience ($p<0.05$), access to climate information ($p<0.05$) and access to extension service ($p<0.05$: $p<0.10$) are all important determinants that influence tomato farmer's choice of adaptation strategies to climate variability in the Offinso North District.

Keywords: *Climate variability, multinomial logit regression, adaptation, tomato production, Offinso North District, Ghana*

1. Introduction

The extent to which climate variability has attracted global attention cannot be over-emphasized due to its adverse implications on humanity and the environment. This global attention has not only emanated because of the oscillations in rainfall pattern and extreme temperature rise, but also because of the lack of preparedness and the requisite capacity to cope with the pressures of the phenomenon through adaptive measures or strategies. The magnitude of the impact of climate variability cuts across almost all spectrum of human endeavour with food security being the most threatened (IPCC, 2014). It is widely argued that, there are differentials with respect to the degree of impact on economies. It is overtly understood that developing countries are the greatest recipient of the impact of climatic variations in regional context (IPCC, 2014).

The agricultural sector is the most vulnerable sector to climate variability due to the reliance of rainfall in the cultivation of both food crops and cash crops (Owomboet al.,2013). Again, since the agricultural sector is the backbone of most developing economies, a significant impact on the sector will largely affect most smallholder farmers, especially those in rural areas whose livelihood mostly depends on agriculture. Ghana's agricultural sector which contributes significantly to the socio-economic development of the country in terms of the gross domestic product (GDP) growth, and employment creation to the youth is mainly rain-fed. As a result, when there is a reduction in rainfall coupled with extreme temperature variation, the GDP as well as employment creation becomes affected.

Tomato (*Lycopersiconesculentum*) is an important vegetable cultivated by male and female farmers in both rural and urban centers in Ghana. Tomato is heavily cultivated in the Offinso North District because the area has arable lands that support the growth of tomato and other vegetables. While some farmers cultivate tomato on a small scale and for subsistence purpose, others cultivate on a large scale for commercial purposes. The livelihood of the people of Offinso North District is highly dependent on the cultivation of tomato. Apart from the provision of livelihood assets to the people, tomato also provides an important source of vitamins to the body. According to Masahumi et al. (2011) high temperatures during flowering induces flower abscission, malformed flowers, and pollen sterility in tomato plants thereby resulting in poor flowering and fruits. The Inter-Governmental Panel on Climate Change (IPCC) uniform climate scenarios show that, a decrease in precipitation of a place could cause a reduction in yield with farmers losing their entire net revenue from crops if precipitation decreases by 14 percent (Kassahun, 2009).

In view of the impact of climatic variations on agriculture and tomato production in particular, farmers have moved away from the need to act, to how to adapt (Bagamba et al., 2012). As a result, adaptation mechanisms have become imperatively relevant in climate variability discourses. Adaptation to climatic changes require the effort of farmers putting together responsive strategies and practices at the various farm-levels which can either be indigenous or scientific depending on the financial capacity of the farmers in the area (Reidsma, 2010).The adoption of sound adaptation measures could go a long way to enhance food security in many parts of sub-Saharan African countries that are identified to be the most vulnerable.

Until now no study has been conducted to analyse the determinants of tomato farmers' adaptation strategies in Ghana and the Offinso North District in particular, especially using amodeling approach. This creates a lacuna in the literature which the study seeks to fill. The objective of the study is to analyse the determinants of tomato farmers' adaptation practices in order to provide an insight into how policy can be formulated to help farmers respond appropriately through sound adaptive measures.

2. Materials and Methods

2.1. Study Area

The study was conducted in the Offinso North District of the Ashanti Region of Ghana, which covers an area of 741kilometres square in size and lies between longitudes $1^0\, 60^1$ W and $1^0\, 45^1$ E and latitudes $7^0\, 20^1$ N and $6^0\, 50^1$ S (See Fig. 1). The Offinso North District lies in the semi-equatorial climatic zone and experiences a double maxima rainfall regime. While the first rainfall season begins from April to June, the second period starts from September to October. The mean annual rainfall is between 1250 mm and 1800 mm. Relative humidity is generally high ranging between 75-80 percent in the rainy season and 70-72 percent in the dry season. A maximum temperature of 30^{o}C is experienced between March and April. The mean monthly temperature is about 27^{0}C.

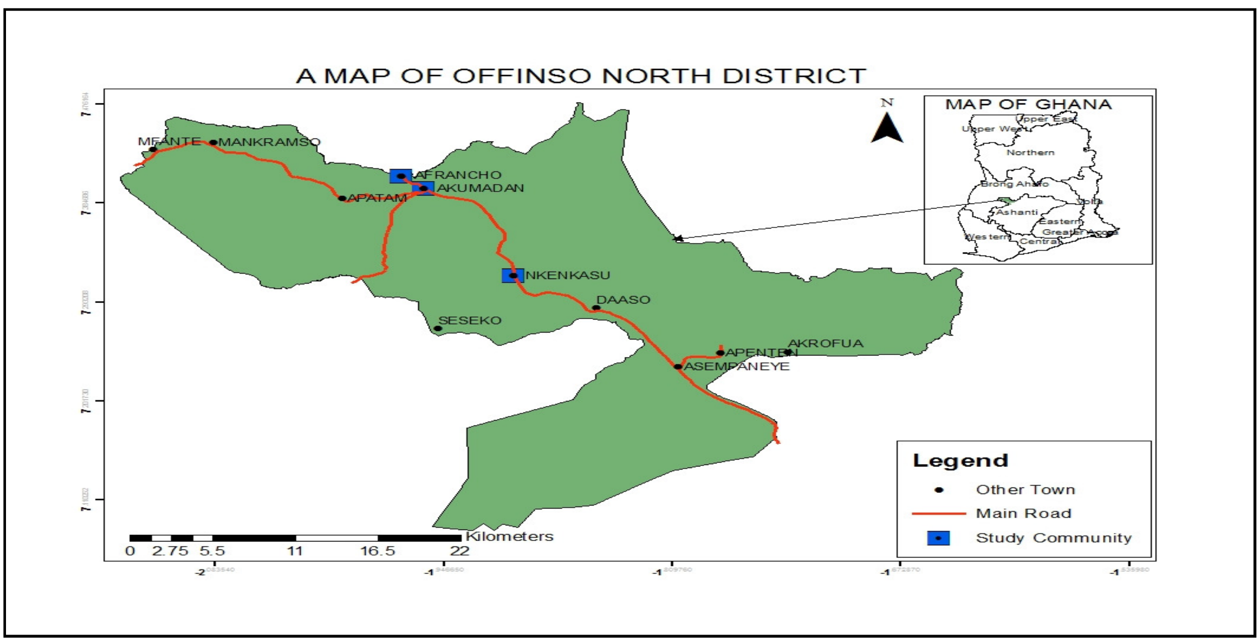

Figure 1: Map of the study area

2.2. Data Types, Sources and Sampling Techniques

The study is a quantitative cross-sectional research which was conducted on smallholder tomato farmers' in the Offinso North District. The quantitative method was useful for the study because it provides a better appreciation of the issues under consideration and helps to clearly represent the issues by quantifying the variables. This helps in providing an objective analysis of the problem with sharpness in generalizing the findings. Primary data for the study were obtained from a cross-section of tomato farmers from three communities using a structured questionnaire. The data collected included farmer's socio-demographic characteristics and their actual adaptation practices employed on the farm and off-the farm. A total of 378 farmers were sampled using the systematic sampling technique.

2.3. Theoretical Framework

The adaptation practices or strategies employed by farmers depend on the satisfaction that is derived from employing that particular strategy at the expense of other strategies. This makes the maximum utilization theory very relevant in analyzing the choices that are made by farmers in their attempt to respond to the pressures of climatic variability. Household characteristics (e.g. age, sex, marital status, income and educational levels of farmers), farm characteristic (e.g. farm size, soil type and fertility), infrastructural factors (e.g. storage facilities and market) institutional factors (e.g. access to credit and extension services) and environmental factors (e.g. temperature and rainfall) are important factors that influence farmers adaptation practices in response to the risks associated with the changing climate (Ibrahim et al., 2011; Maddison, 2007; Nhemachena and Hassan, 2007).

The essence of adaptation is to help absorb the shocks that are normally associated with the pressures exerted on environmental resources by climatic variations (inter alia, changes in rainfall pattern and high temperatures). The analysis used in this particular study is aimed at ascertaining the determinant factors that influence tomato farmers' choice of adaptation options in order to provide sound and efficient policy framework that will enhance the adaptive capacities of farmers to increase the supply of tomatoes in the country and the study area to be specific. The use of multinomial logit and multinomial probit models are very relevant econometric models used in determining the choices people make on things. The use of these analytical techniques help to provide a more cogent analyses on the adaptation decisions made by farmers at both on-farm and off-farm levels. Unlike the multinomial probit regression model, the multinomial logit model is widely used by researchers because of its simplicity in terms of computation of choice probabilities (Tse, 1987). Notwithstanding its simplistic computational manipulations, the model has a limitation of independence of irrelevant alternatives (IIA) property which emphasizes the fact that, the ratio of the probabilities of selecting two different alternatives is independent of the attributes of any other alternative in the selected set (Tse, 1987).

Assuming A_i is considered as a random variable that shows the adaptation options made by individual tomato farmers, then it is assumed that a tomato farmer has an opportunity to choose from a variety of adaptation options which are mutually exclusive and dependent on both climatic (temperature and rainfall) and socio-economic characteristics (sex, age, education level and farm size). Therefore, the multinomial logit model demonstrates some level of relationship between an option, A_i and the set of explanatory variables, X (Greene, 2003) expressed as:

$$\text{Prob}(A_i = j) = \frac{e^{\beta'_j x_i}}{\sum_{k=0}^{j} e_k^{\beta} x_i}, j = 0,1 \ldots J \qquad (1)$$

where β_j denotes the vector of coefficient on each of the independent variables, X. The model in equation 1 is re-modeled by normalizing it to remove all the indeterminacy associated with the model through the assumption that $\beta_0 = 0$ with the probabilities been estimated as:

$$\text{Prob}\left(A_i = \frac{j}{x_i}\right) = \frac{e^{\beta'_j} x_i}{1 + \sum_{k=1}^{j} e_k^{\beta} x_i}, j = 0, 2 \ldots J, \beta_0 = 0 \qquad (2)$$

Estimating the maximum likelihood of equation 2 yields the log-odds ratio presented as

$$In\left(\frac{P_{ij}}{P_{ik}}\right) = x_i^j(\beta_j - \beta_k) = x_i^j \beta_j, \text{if } k = 0 \qquad (3)$$

The outcome (dependent) variable is the log of the alternative relative to the base alternative. Because of the cumbersome interpretation nature of the multinomial logit model coefficient coupled with the tempting nature of associating β_j and the jth outcome, marginal effects (a measurement of the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable) are sometimes derived to provide a good interpretation of the effects of the explanatory variables on the probabilities (Greene, 2003). This is expressed as:

$$\delta_j = \frac{\partial P_j}{\partial X_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k \beta_k\right] = P_j(\beta_j - \bar{\beta}) \qquad (4)$$

2.3.1. Model Variables

The variables that define the model are categorized into two dubbed; the dependent variable and the independent variable. The dependent variables are the adaptation choices of smallholder tomato farmers in the District that portray the various strategies that are employed by tomato farmers to offset the adverse effects of the climate variations on the tomato crop. The independent variables are the socio-demographic characteristics of the farmers, environmental factors and institutional factors that explain the choice of selecting particular adaptation options.

2.3.1.1. Dependent Variables (Adaptation Practices)

There are several adaptation practices that have been discussed in climate variability discourses. While some of the adaptation practices are on-farm (e.g. irrigation, application of fertilizer, changes in crop variety, soil conservation and mulching) others are off-farm strategies (e.g. migration, changing of planting dates and livestock production etc.) (Derresa et al., 2008 and Nhemachena and Hassan, 2007). All these strategies are implemented to help farmers cope with the costs and risks associated with the changing climate and to show resilience in improving their livelihoods (Rodriguez-Solorzano, 2014).

The adaptation practices that are outlined in this study include both the on-farm and off-farm adaptation strategies employed by tomato farmers in the Offinso North District. The employment of these adaptation practices of the tomato farmers helps them to reduce their costs of production as well as increase their livelihood options. The adaptation practices used in this study were elicited from the tomato farmers in the District through their responses from the questionnaires administered. The questions were based on the employment of adaptation practices as a means of reducing the effect of climate variability. Some of the major adaptation strategies employed by the farmers in this study include: mixed cropping, changes in crop variety, changes in farm location, application of agro-chemicals, diversification to non-farm activities, migration and crop diversification. However, it was observed that some farmers did not adapt at all with financial constraint being the main reason why they could not adapt.

2.3.1.2. Independent Variables

A plethora of independent variables influence farmers' choice of adapting to the ever changing climate. The most cited variables in literature include household characteristics (e.g. age, sex, marital status and educational levels of farmers), farm characteristic (e.g. farm size, soil type and fertility), infrastructural factors (e.g. storage facilities and market) institutional factors (e.g. access to credit and extension services) and environmental factors (e.g. temperature and rainfall). However, the independent variables that have been used in this particular work include household factors such as age, educational status, sex, farm experience; farm characteristics such as the farm size; institutional factors such as access to credit, access to climate information and access to extension services.

2.3.1.2.1. Household Characteristics

Age is a major determinant factor of farmers' choice of employing myriads of strategies in response to the effects of climate variability. It is extensively argued that age has a greater positive relationship with one's farming experience and by extension, a person's ability and probability to employ adaptation strategies in response to the pressures of the climatic variations (Nhemachena and Hassan, 2007;Maddison, 2007).However, the study of Shiferaw and Holden (1998) argued differently when they intimated a negative relationship between the age of farmers and their adaptation strategies especially on soil conservation practices as an adaptive mechanism.

Farming experience is another major household characteristic that determines farmers' choice of adaptation practices. The study of Debalke (2014) stresses that, increasing farming experience has a greater positive effect on farmers' adaptation strategies on the farm especially in the area of soil conservation, irrigation and changing of planting dates. The argument is that, the more experienced farmers are, the more likelihood their knowledge in climatic conditions which prompt them to adapt to respond to the effects. While age is agued to have a greater positive relationship with farming experience, Hassan and Nhemachena (2008) stress that, it is experience rather than age that matters in any adaptation process.

Educational status has been reported by several researchers as having a significant positive relationship with adaptation strategies. For instance, the study of Ibrahim et al. (2011) revealed that farmers with higher level of education had a greater likelihood of adapting to the varying climate through the adoption of several sound strategies. Hence, farmers with higher level of education adapted better than those without adaptation strategies. However, studies have also shown that education has no significant relationship with the choice of farmers' adaptation strategies to climate variability (Clay et al., 1998).

The sex of farmers also has some level of relationship with the probability of farmers employing adaptive strategies to respond to the risks of climate variability impact. Studies have shown some female farmers have a higher probability of adapting to climate variability through soil conservation practices (Bayard et al., 2007). However, the study of Bekele and Drake (2003) contradicts this assertion and rather argues that gender has no relationship with the choice of farmers' adaptation strategies.

2.3.1.2.2. Institutional Factors

Access to credit is also identified as having a positive relationship with farmer's ability to adapt to climate variability and change. The higher the access to credit facility by the farmer, the better the farmer stands to effectively adapt to the changing climate (Ibrahim et al., 2011; Maddison, 2007). Therefore, the extent of access to credit facility by a farmer shows the likelihood of that farmer to adapt better than the farmer who had no access to credit facility.

Access to extension servicesis also argued to have a higher level of significance with farmers' choice and ability to adapt through adaptive mechanisms (Ibrahim et al., 2011; Bekele and Drake, 2003). The study overtly showed that, the greater a farmer's access to extension services, the more their awareness of the changing climate and hence the likelihood of the farmer employing adaptive strategies to withstand the pressures of the climatic variations. On the contrary, the study of Birungi (2007) however shows that access to extension services has no significant relationship with farmers' choice of adapting to the varying climate.

Access to climate information also has some relationship with the kind of adaptation practices employed by farmers in responding to the changing climate. As farmers get access to climate information, it is expected that they will be able to adjust their farming strategies to meet the vagaries of the climate which has adverse consequence on their crops. However, it is important to note that just having access to climate information is not the solution, but more importantly the ability to apply the climate forecasts or information (Below et al., 2010) make them more responsive to the pressures of the changing climate.

2.3.1.2.3. Farm characteristics

The size of a farm can also be a determinant factor that influences the choice of smallholder farmers' adaptive mechanisms. The study of Hassan and Nhemachena (2008) demonstrates that large farm sizes allow farmers to adapt through diversification of crops which help them to reduce their losses that may arise as a result of the effect of the climatic variability. Again, Apata (2011) avers that farm size has a negative relationship with farmers' adaptation practices. This was attributed to the fact that adaptation practices are location-based and plot-specific as exemplified in the study of Deressa et al. (2009). This means that the larger the farm size, the less the probability of the farmers employing adaptation strategies to respond to the pressures of the climatic variations.

3. Results and Discussion

3.1. Socio-demographic Characteristics of Respondents

Table 1 is a descriptive analysis of the socio-demographic characteristics of the survey respondents. With respect to the age distribution of the respondents, the results show that majority of the farmers 155 (41%) were between the ages of 31 and 40. This means that the farming population in the district is relatively youthful and has a relatively greater potential for sustainable tomato production.

Regarding the sex distribution, majority of them were males. Out of the total of 378respondents, 262 of them (69.3%) were males while 116 (30.7%) were females. This implies that males continue to dominate in the area of farming activities due to their physical nature and capabilities as compared to females who are less energetic and lack the physique to engage in rigorous activities associated with tomato cultivation.

The educational status of respondents showed that, majority of them 168 (44.4%) had no formal education at all. Again, 134 (35.5%) had education up to the Middle school or Junior High level.

Also, 56 respondents (14.8%) had education up to the primary school level. The least number of respondents (20) were farmers who had education up to the secondary school level. They constituted 3.7 percent.

Socio-demographic Characteristics	Frequency	Percentages (%)
Age:		
<20	14	3.7
20-30	32	8.5
31-40	155	41
41-50	150	39.7
>50	27	7.1
Sex:		
Male	262	69.3
Female	116	30.7
Educational status:		
Primary	56	14.8
Middle/Junior High	134	35.5
Senior High	20	5.3
No formal education	168	44.4
Farming experience:		
<10	12	3.1
10-20 years	162	42.9
21-30 years	161	42.6
31-40 years	37	9.8
>40 years	6	1.6
Access to credit:		
Yes	24	6.3
No	354	93.7
Access to extension service:		
Yes	30	7.9
No	348	92.1
Observation of climate variability:		
Yes	378	100
No	0	0.0
Farm size:		
1-2 acres	49	13
3-4 acres	158	41.8
5-6 acres	118	31.2
7-8 acres	38	10
9 and above	15	4.0

Table 1: Socio-demographic characteristics of respondents (n=378)
Source: Authors fieldwork, 2014

This implies that majority of the respondents had little or no educational attainment which may influence their adaptive strategies through the adoption of traditional strategies instead of scientific strategies in responding to the impact of the climate variability. Most of these respondents who had little or no education were the female farmers

In terms of farming experience, majority of the respondents, 162 (42.9%) had been in the tomato business between 10 and 20 years, 161 (42.6%) respondents were into the tomato business between 21 and 30 years. It was noted that majority of these respondents with high experience were the men. Also, 37 (9.8%) respondents had been in the business between 31 and 40 years with 12 (3.2%) respondents engaged in the business for less than 10 years. The least years of experience of farmers who had been in the tomato business was 6 (1.6%), and they were the females. This may be due to the ample time women spend at home performing social roles such as cooking, washing and child bearing which limit their engagement in farming activities as compared to the men.

The analysis further showed that majority of the respondents, 354 (93.7%) indicated that they do not have access to credit facilities to boost their tomato business. This means that the farmers adaptive capacities would be affected which may have far-reaching implications on their yield and livelihood.

In the area of access to extension services as a means of enhancing their adaptive capacities, majority of the sampled respondents, 348 (92.1%) indicated that they do not have access to extension service. This means that, most of the farmers will be sticking to their conservative and old ways of adapting to observed climatic variations which may not yield productive results in the long term.On the issue of whether the climate has become variable, the respondents indicated that they have observed some variability regarding the rainfall pattern and temperature. This knowledge could go a long way to influence their adaptation practices both on the farm and off the farm.

The size of the farms of respondents was also obtained from the tomato farmers in the district. The results indicate that majority of them, 158 (41.8%) cultivated between 3 to 4 acres of farmland, 118 (31.2%) cultivated a farmsize of 5 to 6 acres, 49 (13%) of the farmers cultivated 1 to 2 acres, 38 (10.1%) farmers cultivated between 7 and 8 acres of farmland while 15 (4.0%) of the farmers cultivated 9 acres and above of farmland. This means that the land tenure system in the area is not permitting many farmers to own large acres of land for farming. Again, the low financial capacity of most tomato farmers may not permit them to cultivate on a large scale.

3.2. Determinants of Tomato Farmers' Adaptation Practices

The factors that influence tomato farmer's adaptation practices in absorbing the shocks of climate variability effects on their production were determined using the multinomial logit model. The reference category for the multinomial logit analysis was those who did not adapt any strategy in response to the observed climatic variability. The chi-square value of 384.256 and the associated log likelihood ratio was significant ($p<0.05$). This shows a very high predictive power of the regression model. Appendix 1 shows the result of the multinomial logit analysis.

Regarding gender as a variable influencing tomato farmer's adaptation strategies, the study found that, gender is significant ($p<0.05$) but negative for agrochemical application and mixed cropping with associated odd values of 0.24 and 0.28 respectively. This implies that there is greater probability of more men not choosing these strategies. This is inconsistent with Bekele and Drake (2003) who opine that gender has no relationship with farmers' adaptation strategies. This is due to the fact that different farmers have different preference for certain strategies based on their financial capacity.

Also, the coefficient of farmers age was found to be significant ($p<0.01$) but negative for employing adaptation strategies of diversification to non-farm activity and changing crop variety. The odd values of farmers not adapting to diversification to non-farm activities and changes in crop variety were 0.13 and 0.12 respectively. This implies that an increase in the variable will decrease the likelihood of the sampled respondents choosing the above-mentioned strategies. This is consistent with Shiferaw and Holden (1998) who asserted that age has a negative relationship with farmers' adaptation strategies. However, the study was inconsistent with the study of Nhemachena and Hassan (2007) who identified a positive relationship between the age of farmers and their adaptation practices. Generally, unlike the youth, the aged do not normally have the strength to employ adaptation strategies that are energy demanding.

With respect to the marital status of the farmers, the result showed that the marital status of the farmers was significant ($p<0.10$) and positive for crop diversification and application of agrochemicals with associated odd values of 1.88 and 1.63 respectively. This means that married farmers were more likely to choose the afore-mentioned strategies. This is due to the fact married farmers are more vulnerable to the effects of the climatic variations due to the responsibilities they have in taking care of their family. As a result, they employ crop diversification and agrochemicals to widen their opportunities of absorbing the shocks of climate variability.

On the educational status of the farmers the study found that, formal education was significant ($p<0.1$) and negatively affected the adaptation mechanisms of farmers to crop diversification, changing crop variety and changing farm location. This was not in conformity with the a priori objective of the study. The associated values of choosing these strategies by the respondents as against not adapting at all were 0.11, 0.02 and 0.14 respectively. This implies that farmers who had formal education were less likely to adapt through diversification of crops, changing the variety of crop and changing the location of their farmers. This may be due to the fact that farmers with formal education may believe in employing improved soil fertility strategies such as application of fertilizer than to resort to the afore-mentioned strategies. This is inconsistent with the study of Ibrahim et al. (2011) who observed that farmers with higher level of formal education have a greater likelihood of employing sound adaptation strategies in response to the climatic variability.

In terms of access to credit facility, the study revealed that the variable is significant ($p<0.05$) and positively influenced the adaptation options of the farmers in the area of crop diversification with an odd value of 8.59. This implies that if more farmers had access to credit facilities, it will increase their likelihood to adapt through crop diversification. This means that as farmers income increase through access to credit, they are able to invest into the cultivation of other crops which are more weather resistant. This is consistent with Maddison (2007) who explains that the more a farmer gets access to credit, the higher the probability of that farmer employing effective adaptation strategies. This is true of the expectation of the study as most farmers complained of financial difficulty as a constraint to their ability to adapt. Hence, with the needed financial capacity, farmers will be able to adapt appropriately.

The co-efficient of the farm size of respondents to their adaptive measures was found to be significant ($p<0.01$) but negative to mixed cropping as an adaptive strategy to the effect of climatic variation on tomato production. The odd of applying this strategy as against not applying at all is 0.33. This means that an increase in the farm size of farmers decreased their likelihood to adapt through mixed cropping. This implies that, as farmers increase their farm size, it becomes difficult in employ different agronomic and farm management practices to suit the various varieties of crops on the same piece of land. This is consistent with Apata (2011) who avers that farm size has a negative relationship with adaptation strategies of farmers. Even though large farm size helps farmers to have wider opportunities of absorbing the shocks of the effect of the climatic variability, it is more tedious to manage several crops on the same piece of land. Again, a disease of a particular crop can spread to affect the other crops thereby increasing crop loss and production cost.

How long a farmer had been engaged in farming was found to be significant ($p<0.05$) and positive to crop diversification, application of agrochemicals, mixed cropping and changing crop variety with their respective odd values of 1.11, 1.54, 1.59 and 1.02. This implies that the larger the period farmers engage in farming, the more likelihood of them employing the above-mentioned strategies. This is in consonance with the a priori expectation of the study. This is because as farmers gain more experience they are able to vary their on-farm adaptation strategies to suit the dynamics of the changing climate. This finding is consistent with Debalke (2014) who stresses that, the more experienced a farmer is, the greater his chances of adapting positive strategies on the farm.

Access to agricultural extension services was also found to be significant ($p<0.05$) but negative for diversification to non-farm activities with an odd value of 0.15. This implies that an increase in access to extension services will decrease farmers' likelihood to adapt through the above-mentioned strategy. This is due to the fact that extension officers of MoFA educate farmers on best farming practices and all agronomic issues relating to farming with no emphasis on off-farm activities. Again, the variable was significant ($p<0.10$) for application of agrochemicals and positive implying that an increase in access to extension services could increase the probability of farmers applying agrochemicals an adaptive measure. This is true because farmers who had access to extension services had more information on the changing climate and hence employed agrochemicals to boost crop yield. This supports the study of Ibrahim et al. (2011) who assert that farmers who have access to extension services increase their likelihood to employ adaptation measures.

Access to climate information was found to be significant ($p<0.05$) and positive for changing the location of their farms as an adaptive strategy. This was confirmed by the odd ratio of 1.48 which shows that, as farmers' access to climate information increase they have greater likelihood of changing the location of their farms. This is consistent with the a priori expectation of the study because, climate information provides farmers with the opportunity to plan appropriately for the cultivation of their crops. Therefore, with increased access to climate information they will be able to adjust by moving to other farm locations that are closer to rivers and forest areas which are potential rainfall areas. This validates the study of Below et al. (2010) who opined that farmers' ability to apply climate forecasts or information are important factors that determine their adaptation strategies.

4. Conclusion

The study was conducted to analyse the factors that influence the choice of smallholder tomato farmers' choice of adaptation strategies using an econometric model. The result of the multinomial logit regression model confirmed that smallholder tomato farmers' adaptation strategies are influenced by a number of socio-demographic, farm level, institutional and environmental factors. Prominent among these variables included marital status, gender, age, education, farm size, farming experience, access to climate information and access to extension services. It was also observed that while some of these variables positively influenced the farmers, others had negative influences on them. Variables such as marital status, access to credit facility, farming experience, access to climate information and access to extension services positively influenced tomato farmers' choice of adaptation practices in their quest to respond to the effects of climatic variability on tomato production. However, variables like age of farmers, gender, education and farm size negatively influenced tomato farmers' decision in employing some adaptation strategies in response to the effects of the climatic variations. Therefore, farmers should be encouraged to get some education. This can positively inform their decision in employing sound adaptive measures in response to the climatic variability on tomato production. One way of achieving this is to encourage the farmers to enroll in non-formal education in the country that emphasize literacy and numeracy skills of elderly people. This will enable farmers to read and understand simple instructions relating to application of agrochemicals as well as being informed of the new technological ways of farming. There is also the need for the government and civil societies to help farmers get access to finance to enable them implement sound adaptation strategies. This can be done through subsidizing key agricultural inputs so as to make them available and easily accessible to the farmers. Farmers can also come together to form cooperative union or society that can enablethemaccess financial support to cushion their farming business. This will help empower women and those with large farm sizes to employ the needed strategies to cope with the climatic variability. There is also the need for the farmers to be provided with climate information through the various media in the area (e.g. radio station and information center) to enable them plan adequately for the planting season.

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Appendix 1: Determinants of respondents' adaptation practices Standard errors are in parenthesis

Variable	Crop diversification	Odd ratio	Diversification to non-farm activity	Odd ratio	Agrochemical application	Odd ratio	Mixed cropping	Odd ratio	Changing crop variety	Odd ratio	Changes in farm location	Odd ratio
	Parameter		Parameter		Parameter		Parameter		Parameter		Parameter	
Gender	-.509 (.638)	.60	-.994 (.750)	.37	-1.433** (.547)	.24	-1.263** (.578)	.28	-.271 (.707)	.76	-16.653 (571.092)	5.86
Age	-.098 (.487)	.91	-2.007*** (.553)	.13	-.136 (.440)	.87	.688 (.464)	1.99	-2.121*** (.696)	.12	.635 (.530)	1.89
Marital status	.631* (.334)	1.88	-.573 (.718)	.56	.491* (.298)	1.63	.108 (.315)	1.11	-.009 (.629)	.99	.023 (.455)	1.02
Formal Education	-2.221*** (.633)	.11	.464 (.720)	1.59	-.780 (.554)	.46	-.638 (.576)	.53	-4.118*** (1.058)	.02	-1.996*** (.665)	.14
Access to credit	2.151** (1.016)	8.59	15.803 (.000)	7300407.6	.995 (.750)	2.70	.434 (.818)	1.54	17.134 (.000)	27610493.58	16.324 (.000)	12289430.29
Farm size	.263 (.359)	1.30	.018 (.376)	1.02	-.505 (.316)	.60	-1.115*** (.333)	.33	-.574 (.466)	.56	-.537 (.367)	.59
Access to Climate information	-16.001 (642.364)	1.13	-17.095 (642.365)	3.77	-15.018 (642.364)	3.00	-16.124 (642.364)	9.94	-17.578 (642.365)	2.32	.388** (.000)	1.48
Farming Experience	.108** (.315)	1.11	0.00 (7991.94)	1.0	.434** (.818)	1.54	.464** (.720)	1.59	.018** (.376)	1.02	-18.607 (.000)	8.30
Access to Extension services	.088 (.849)	1.09	-1.928** .940	.15	1.495* (.884)	4.46	1.186 (.885)	3.28	.026 (1.153)	1.03	16.824 (.000)	20258211.69

****, **, * implies statistical significance at 10%, 5% and 1% respectively*

Source: Computed from survey data, 2014