

Research Application Summary

Factors affecting the adoption of climate risks adaptation strategies within maize farming systems in Malawi: Do farmers risk attitude matter?

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Abstract

This study examined the risk attitude of farmers on climatic change and how this influences the choice of climate variability adaptation strategies to mitigate the effects of climatic risks. Using 2012 and 2015 household panel data of 346 households from six districts of Malawi, the pooled multinomial logit model was used to identify the factors that influence the choice of climate variability adaptation strategies by smallholder farmers in Malawi. We aimed to identify the factors that influence the choice of climate variability adaptation strategies from a pool of factors that were tested such as reduced food consumption, selling of labour, savings and use of technologies by smallholder farmers. The results show that the choices of adaptation strategies to climatic shocks are similar across the study regions. However, significant factors influencing the responses are not the same. Despite the differences in the choice of adaptation strategies between floods and droughts victims, the results pointed out the importance of frequency and duration of shocks, agro-ecological zone, and risk attitude of the household decision maker. The paper argues that risk attitude along with some socio-economic characteristics of smallholder farmers influence the choice of climate variability adaptation strategies under climate risk. The study recommends the incorporation of risk attitude variable when evaluating farmer's decision making amidst climate change.

Key words: Climate risks, decision making, Malawi, pooled Multinomial logit, risk attitude, smallholder farmers

Résumé

Cette étude a examiné l'attitude des agriculteurs vis-à-vis du changement climatique face au risque et comment cela influence le choix des stratégies d'adaptation à la variabilité climatique pour atténuer les effets des risques climatiques. En utilisant les données du panel de ménages de 2012 et 2015 de 346 ménages de six districts du Malawi, le modèle logit multinomial groupé a été utilisé pour identifier les facteurs qui influencent le choix des stratégies d'adaptation à la variabilité climatique par les petits exploitants agricoles au Malawi. Nous avons cherché à identifier les facteurs qui influencent le choix des stratégies d'adaptation à la variabilité climatique à partir d'un ensemble de facteurs testés tels que la réduction de la consommation alimentaire, la vente de main-d'œuvre, l'épargne et l'utilisation des technologies par les petits exploitants agricoles. Les résultats montrent que les choix de stratégies d'adaptation aux chocs climatiques sont similaires

à travers les régions d'étude. Cependant, les facteurs significatifs influençant les réponses ne sont pas les mêmes. Malgré les différences dans le choix des stratégies d'adaptation entre les victimes des inondations et des sécheresses, les résultats ont souligné l'importance de la fréquence et de la durée des chocs, de la zone agro-écologique et de l'attitude face au risque du décideur du ménage. Le document soutient que l'attitude face au risque ainsi que certaines caractéristiques socio-économiques des petits exploitants agricoles influencent le choix des stratégies d'adaptation à la variabilité climatique face au risque climatique. L'étude recommande l'incorporation de la variable d'attitude face au risque lors de l'évaluation de la prise de décision des agriculteurs face au changement climatique.

Mots clés : Risques climatiques, prise de décision, Malawi, logit multinomial groupé, attitude face au risque, petits exploitants agricoles

Introduction

In scholarly debate, understanding smallholder farmers' behaviour under climatic risks is essential for improving their adaptive capability to promote sustainable agriculture in developing countries, Malawi inclusive (Katengeza *et al.*, 2016; Phuong *et al.*, 2017). A study by Collier and Dercon (2014) postulated that smallholder farmers are key players in transforming agriculture. They implement adaptive climate related strategies aimed at improving sustainable agricultural policies for mitigating the impact of climate related risks. However, studies that articulate the behavioural attributes of farmers in a climate risk environment with the aim of improving maize availability have been scanty. For instance, Home *et al.* (2014) looked at how behaviour of farmers influenced their adaptation decisions and sustainability of nature conservation. However, the adopted approach exhibited limited aspects of resource allocation. As such, the results have not been generalised to direct policy on the behaviour of farmers in resource allocation and climate risk. Theory suggests that farmers who are familiar or have witnessed climate change related occurrences have high chance of believing in the anticipated climate risks in future, and subsequently embrace practices that can protect them from any related climatic effects. Current literature on climatic related risk opinion is centred upon individual knowledge and the public beliefs of risks related to climate change (Myers *et al.*, 2017). Despite the growing body of literature on farmer's opinions of risks associated with climate change, majority of the studies are descriptive.

Typical relations between climatic risks and adaptation strategies have been partially investigated and quantified. For example, Wheeler *et al.* (2013) examined the perceptual links stemming from planned behavioural theory. They studied how farmers' beliefs in climatic risks induce the selection of actual and planned climate change adaptation strategies at farm level in Australia. Inclusion of climatic risks and individual risk attitude could highlight the relations between opinions of farmers on related phenomena of climatic risks and their authentic behaviour of adaptation. The insight might inform future adaptation strategies to climate change in the agricultural sector that are effective and sustainable. The variation in the choices of the risk coping strategies (Udo *et al.*, 2015) occur due to the existence of heterogeneities across the farm households (Legesse and Drake, 2005). The decisions are therefore subject to changes in the environment, economic, social conditions, and the risk attitude of farmers (Sonwa *et al.*, 2017). Recent studies have incorporated the impacts of climate variability on crop production (Alemayehu and Bewket, 2017; Assa *et*

al., 2017; Moroda *et al.*, 2018), however, the influence of individual risk attitude in selection of specific climate variability adaptation practices on farm level production are still scanty. This paper builds on the previous studies by examining factors that influence smallholder farmers choice for climate variability adaptation strategies. Its specific objectives are to (i) assess farm-level climate variability adaptation strategies from a pool of factors such as reducing food consumption, selling of labour, savings and use of technologies by smallholder farmers, and (ii) ascertain if farmers risk attitude influence climate variability adaptation choices.

Materials and Methods

Study Site. Data used for this study were sourced from the farm household data which were collected by the International Maize and Wheat Improvement Centre (CIMMYT) in 2012 and 2015, from 346 household, in Thyolo, Chiradzulu, Machinga, Zomba, Kasungu and Lilongwe districts (Katengeza *et al.*, 2016). This gives a two year-round panel of household data. The primary sampling units were the enumeration areas following the Integrated Household Survey (IHS) of 2004 by the National Statistical Office, Malawi. The household population figures used for the enumeration areas are those from the 1998 population census. In Thyolo, Chiradzulu and Machinga districts, two enumeration areas were randomly selected, while in Zomba, Kasungu and Lilongwe Districts, three enumeration areas were randomly selected. Data from 2012 were used specifically to obtain the risk levels generated from the gambling exercise.

Pooled Multinomial Logit Model. The pooled Multinomial logit model (MNL) was used to analyse factors influencing the choice of climate variability adaptation strategies amongst smallholder farmers. The model specifies the relationship between the probability of choosing an adaptation option and the set of explanatory variables (Deressa *et al.*, 2009; Magombo, 2012). Pooled MNL model was used over random effects MNL and other Limited dependent variable (panel data) models because it is difficult to achieve convergence over quadrature due to the nature of the dependent variable which had more than three categories as explained in Guloba (2014), i.e., the generalized linear latent and mixed models (GLLAMM) command developed by Rebe-Hesketh *et al.* (2004) is slow to estimate the random effects MNL model in STATA which is considered a major limiting factor. The panel surveys identified some household members who are not adapting whilst others are selling assets, using past savings, and withdrawing children from school to adapt to varying climate. Other strategies include migration, reducing consumption, and reliance on help from relatives, friends, and local governments. Other strategies include wage employment, changing crop choices, use of technologies (drought tolerant maize, irrigation, fertilizer, conservation agriculture and pesticides), self-employment and increasing agriculture labour supply. Sampled households were asked to indicate the most preferred adaptation strategy hence use of the MNL which assumes that choices are mutually exclusive from each other.

Following empirical literature (Below *et al.*, 2010; Hisali *et al.*, 2011), the above adaptation strategies were collapsed into five (unordered) categories that are mutually exclusive and are specific for climatic shock. To attain mutual exclusiveness only the most preferred adaptation strategy was chosen for analysis. The five strategies include: (i) no adaptation; (ii) labour supply, increasing wage employment, self-employment, increasing agriculture labour supply, out-migration and withdrawing children from school; (iii) reducing consumption/ food intake and skipping meals; (iv) savings-using up assets and past savings including selling assets and utilising savings; and (v) agricultural technology-based adaptation strategies such as changes in crop

choices and improving technology. Based on the five formulated categories, choices of coping strategies for drought as a climatic risk are generated for analysis. Drought is defined in this paper as a natural feature of climate and is usually allied with warm and dry weather over an extended period (dry spells) causing less than normal water available at the land surface (Glad, 2010) required for crop (e.g., maize) growth. The pooled MNL model was specified as follows:

$$Y_{it} = \ln\left(\frac{p_i}{p_1}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \varepsilon_i \dots \dots \dots (1)$$

Where; Y_{it} = adaptation strategy against drought (adaptation strategies; doing nothing; labour supply; reducing consumption; savings and agricultural technology). X_{it} , where $i = 1, 2, \dots, 12$, are explanatory variables, and t is the number of years for the panel data (2012 and 2015). The dependent variables are explained in the following sub-section.

Independent variables

Age of Household Head. Several studies have included age as an important factor in the process of adopting a technology (Fischer *et al.*, 2015; Kassie *et al.*, 2015). It is believed that as time passes by, farmers become more knowledgeable and accumulate more capital which enables them to take up new technologies (Nkamleu *et al.*, 2005). Consequently, younger farmers are more likely to adopt new innovations because they are better equipped to deal with risk. As such the expected sign on age (a proxy for experience) is indeterminate.

Maize requirement. Maize being a staple food crop is expected to be adapted to climatic shocks for smallholder farmers to continue realising higher yields for survival (Muzhingi *et al.*, 2008).

Education level of household head. Like age, the importance of education of household head has been cited in many empirical studies as it positively relates to technology adoption (Genius *et al.*, 2013; Ogada *et al.*, 2014). Education creates a favourable mental attitude for the acceptance of new practices especially of information-sensitive and management-sensitive practices (Shaw, 2014). The expected sign on the education variable is positive on the assumption that more educated farmers are capable of processing and understanding new information about a technology.

Access to extension services. Reliable agricultural information can influence the decision of farmers to adopt new innovations by shaping attitudes and increase awareness of agricultural households on the available technologies (Mullins *et al.*, 2018). Sources of information include government extension programs, non-governmental organizations, farmer groups or field schools (Kundhlande *et al.*, 2014) and the media such as radio and television. Since the major conduit through which new ideas are transmitted to farmers is extension, this study assessed the role played by agricultural extension in the adoption of improved maize seed and inorganic fertilisers in Malawi. The expected sign of the coefficient on access to agricultural extension is positive.

Club membership. Farmer groups assist smallholder farmers to learn from each other about new technologies through interactions and discussions. This enhances technology uptake; hence a positive relationship is assumed between club membership and the use of drought tolerant maize seeds.

Household labour. Labour input is paramount in any agricultural production enterprise especially in Malawi where nearly all farm work is done manually (Simtowe, 2006). Fertiliser application and planting, which require special knowledge, demand additional labour from the farm households. Farmers with adequate labour supply are more likely to adopt improved maize seed and inorganic fertilisers faster than those with inadequate labour supply (Croppenstedt *et al.*, 2003). A positive relationship is hypothesised between adoption and labour input which was measured in labour-days taking into consideration age, gender, and availability of household members.

Farm capital. Household wealth measures socioeconomic status of farm households via physical assets and is used as a proxy of household income or expenditure. Despite its application in socio-economic analysis, income or expenditure faces difficulties in accounting and seasonality issues. In this study, farm capital is the aggregate costs incurred in the production of maize.

Land size. Land is considered an important asset in the smallholder farming systems in that farmers with larger plots can take the risk of adopting a new technology because they can afford to allocate a part of their plot to the new technology (Genius *et al.*, 2013). As such the expected sign on farm size is positive. Studies that examined the impact of farm size on agricultural household adoption decisions suggested that this relationship depends on several variables which include initial adoption costs, farmers risk preferences, human capital, credit constraints, labour requirements, and land ownership (Genius *et al.*, 2013).

Frequency of droughts as climatic shock. Frequency of droughts as a climatic shock is captured as the number of times a farm household experienced drought. The variable is captured based on a recall period of 2 to 10 years. Three climatic shocks were identified in this study namely, drought, flood, and hailstorm. Households that are more frequently exposed to climatic shocks are more likely to adopt one or more climate variability adaptation strategies.

Duration of climatic shocks. It is critical to cogitate the past duration taken by specific climatic shocks because this information guide farmer in selecting specific adaptation strategies (Cooper *et al.*, 2013). The duration of climate shock is captured as number of weeks that specific climatic shocks lasted.

Agro-ecological zone. Farmers located in drought prone areas are more likely to adopt drought resistant maize varieties than those located in other areas (Piya *et al.*, 2013). Thus, a farmer's location plays a significant role in choosing sustainable adaptation strategies.

Risk aversion. Risk preferences are important in every-day decision making at a farm. Assessing individuals' risk preferences can be useful for investigating possible interaction effects between the focus variables in this case (decision to adapt to climatic shock) and risk preferences (Gloede *et al.*, 2015).

Results and Discussion

Factors determining choice of adaptation strategies against droughts. Likelihood ratio of the pooled MNL model which is indicated by the chi-square statistics is highly significant ($P < 0.01$) indicating the accuracy of the specified model (Table 1). The Variance Inflation Factor for Independent Variables (VIF) results ruled out the presence of multicollinearity in the model.

Robust standard errors were used in the model to rule out any cases of heteroscedasticity. No adaptation was used as a base category for the model. There are five adaptation strategies discussed and these include (i) no adaptation; (ii) labour supply (increasing wage employment, self-employment, increasing agriculture labour supply, out-migration and with drawing children from school); (iii) reducing consumption/ food intake and skipping meals; (iv) savings(using up assets and past savings including selling assets and utilising savings); and (v) agricultural technology (based adaptation strategies such as changes in crop choices like use of drought tolerant varieties, irrigation, conservation agriculture, box ridges and other improved technologies).

Effects of age of household head on the choice of labour supply as adaptation strategy for droughts. It is hypothesised that more experienced households have better adaptive capacity and awareness against climate change. The drought model results from Table 1 shows that, in times of droughts, if the age of the household head increases by one unit, the relative risk of the household to sell its own labour relative to doing nothing will reduce by a factor of (0.9670) given that all other variables in the model are held constant. These results imply that as farmers grow old, they acquire more knowledge and experience on different climate adaptation strategies. As such the likelihood of selling labour among other strategies reduce to maintain household labour requirements. Among other available options is the use of DTM varieties which survive drought and enhance household food security. These results conquer with the findings of Shongwe *et al.* (2014) who found age to be negatively influencing adaptation of climate variability. On the contrary, Hassan and Nhemachena (2008) and Deressa *et al.* (2009) observed significant influence of farming experience on adaptation to climate variability. This means influence of age on adaptation of climate variability depends on the type of shock being experienced.

Effects of education level of household head on the choice of selling labour as adaptation strategy for droughts. Results from Table (1) show that in times of droughts, as the number of school years of the household head increases, the relative risk for selling household labour relative to doing nothing reduces by a factor of (0.9066) given that other variables are held constant. This implies that as the education level of a farmer increase, the probability of selling labour to adapt to drought reduces as farm households opt for alternative sustainable adaptation strategies that deal directly with droughts. Relatedly, Deressa *et al.* (2009), Alauddin and Sarker (2014) and Alam *et al.* (2016) observed that farmers with better education were likely to adapt to climate variability shocks in Ethiopia, Pakistani and Bangladesh respectively. In these studies, more consideration was on adaptation strategies that are more sustainable. However, in this study we have included sale of labour by a farmer as an adaptation option. In Malawi, this option is very common for low-income people with limited education and very limited options for sustaining their livelihoods.

Effects of frequency of climatic shock on choice of selling labour as adaptation strategy for droughts. From Table (1) when households are hit by drought frequently the relative risk for selling labour relative to doing nothing increases by a factor of (1.227) given that all other variables in the model are held constant. This implies that when households are hit by droughts frequently, they prefer to sell labour to adapt for drought as opposed to not adapting.

Effects of period climatic shock took on choice of selling labour as adaptation strategy for droughts. In Table 1 it is noticed that when length of drought increases by one unit, the relative risk for selling labour relative to doing nothing increases by a factor of (1.3566) given that all other variables in the model are held constant.

Table 1. Pooled MNL relative risk ratio (RRR) estimates for factors determining adaptation strategies against droughts

Adapting for droughts	Labour supply RRR	Reduce consumption RRR	Savings RRR	Technology RRR
Age of Household Head	0.9670 (0.0119) ***	0.9969 (0.0180)	1.0052 (0.0088)	1.0014 (0.0073)
Household maize annual requirement	1.0000 (0.0005)	0.9981 (0.0012)	1.0013 (0.0004) ***	1.0007 (0.0003) **
School years of household head	0.9066 (0.0518) *	1.0292 (0.0944)	0.9632 (0.0359)	0.9383 (0.0292) **
Access to Extension (yes)	1.2853 (0.7541)	1.4768 (0.9833)	0.6908 (0.2495)	1.1167 (0.3164)
Belong to a farmer club (yes)	1.8394 (1.0937)	0.5945 (0.5196)	2.1486 (0.7827) **	2.1727 (0.6651) **
Available labour hours	0.9999 (0.0002)	1.0006 (0.0004) *	0.9996 (0.0001) ***	0.9997(0.00009) ***
Farm Capital	1.0000 (6.70e-06)	1.0000 (8.81e-06)	0.9999 (6.12e-06)	1.0000(4.50e-06) ***
Land size	0.9906(0.2205)	0.7794 (0.1192)	0.9887 (0.0154)	0.9988 (0.0130)
Times droughts occurred (past 10 yrs.)	1.22673 (0.1759) *	0.8737 (0.1783)	1.3815 (0.1623) ***	1.2531 (0.1210) **
Duration of drought	1.3566 (0.1081) ***	1.3864(0.1147) ***	1.4468 (0.0798) ***	1.4656 (0.0790) ***
<i>Agro ecological zones</i>				
Medium Altitude	4.2598 (3.7635)	3.86e+07 (2.30e+07) ***	5.2842 (2.7899) ***	2.3093 (0.7923) **
High Altitude	1.1482 (1.0650)	0.5026 (0.4464)	2.8070 (1.4814) *	0.8691 (0.3051)
<i>Risk Attitude</i>				
Risk averse	1.0796 (0.4809)	2.38e-08 (1.82e-08) ***	1.7802 (0.4926) **	2.8497 (0.6198) ***
Constant	0.0733 (0.0.1024) *	1.09e-08 (1.46e-08) ***	0.0061 (0.0059) ***	0.0420 (0.0282) ***
<i>Diagnostics</i>				
Sample	674	Wald chi2(52)	3130.08	
Log likelihood	-660.26134	Prob>chi2	0.0000	
Base Outcome	No adaptation	Pseudo R2	0.2268	

Data Source: CIMMYT/ LUANAR 2012 and 2015 household panel
Notes: In the parenthesis, are robust standard errors for all estimates to allow non-independence in errors at the household level; **p*< 0.1, ***p*< 0.05, ****p*< 0.01

Reduced food consumption relative to not adapting to drought. When the household is hit by drought, the relative risk of reducing food consumption changes by a factor of (1.000). This entails that when the household increases its labour supply in times of drought it will remain indifferent between reducing food consumption and doing nothing to adapt to the climatic shocks.

Effects of number of times climatic shock occurred on choice of reducing food consumption as adaptation strategy for droughts. When the household is hit by drought frequently, the relative risk of reducing food consumption increases by a factor of (1.3864). This implies that increase in the frequency of droughts will significantly ($P < 0.01$) increase the probabilities of reducing food consumption as opposed to not adapting.

Effects of geographical location on reducing food consumption as adaptation strategy for droughts. Geographical location has significant effects on floods and drought occurrence. As such farmers in different geographical location might devise different strategies to mitigate the shocks. In times of drought (Table 1), if a farmer is in medium altitude areas, the relative risk for reducing food consumption relative to doing nothing would increase by a factor of $3.86e+07$ given that other variables in the model are held constant. This implies that farmers in medium altitude areas are more likely to reduce food consumption in times of droughts.

Savings relative to not adapting to drought

Effects of belonging to a farmer club on savings as adaptation strategy for droughts. Belonging to a group in rural areas entails social capital. In times of droughts (Table 1), if a farmer belongs to a farmer club relative to not belonging to a farmer club, the relative risk for using saving relative to doing nothing would be expected to increase by a factor of (2.1486) given that other variables in the model are held constant. At times it is through the society where farmers get ideas of saving and even market opportunities to sell assets and some other saving strategies.

Effects of available labour hours on savings as adaptation strategy for droughts. Results from Table 1 show that in times of droughts, if a farmer is to increase their household labour hours by one unit the relative risk for using savings relative to doing nothing would be expected to decrease by a factor of (0.9996) given other variables in the model remain constant. This entails that available labour hours reduce the relative probability of using savings compared to doing nothing in times of drought.

Effects of time droughts occurred in the past ten years on savings as adaptation strategy for droughts. The results in Table 1 show that frequency of droughts significantly ($P < 0.01$). Increase the probability of using savings. In other words, if there is one-unit increase in the frequency of floods experienced by farmers the relative risk for using savings relative to doing nothing is expected to increase by a factor of (1.3815) given that other variables in the model are held constant. This result suggests that when households are hit by drought frequently, the probability of employing savings will increase as opposed to not adapting at all.

Effects of risk attitude on savings as adaptation strategy for droughts

In times of droughts the relative risk relative for using savings relative to doing nothing by risk averse farmers would increase by a factor of (1.7802) given other variables in the model are kept constant.

Use of technologies relative to not adapt as adaptation strategy for floods or droughts

Effects of annual food requirement on the choice of using technologies as adaptation strategy for droughts. In times of drought, one-unit increase in farmers' annual maize requirement would change the relative risk for using technologies relative to doing nothing by a factor of (1.001) given that other variables in the model are held constant. This implies that farmers will be indifferent between employing technologies or doing nothing in times of drought while in times of floods they will opt to do nothing rather than using technologies.

Effects of education level of household head on the choice of using technologies as adaptation strategy for droughts. The results from Table 1 suggest that a unit increase in the years of schooling of household head would decrease the relative risk for using drought adaptation technologies by a factor of (0.9383) relative to doing nothing given that other variables in the models are held constant. This implies that as the education level of farmers' decrease, they are likely to employ technologies in times of drought. The results concur with Genius *et al.* (2013), Liu, (2013); Van der Kroon *et al.* (2013); Abdulai and Huffman (2014) and Ogada *et al.* (2014) who found mixed results on the role of household head education on adoption of climate change adaptation strategies.

Effects of belonging to a farmer group on technologies adaptation strategy for droughts. Use of technologies to adapt to climate variability shocks require knowledge and experience which is usually acquired through learning from each other. Poor access to information through farmer clubs limit farmers to gain knowledge and use technologies to mitigate the effects of floods and drought as opposed to not adapting at all. The study results from Table 1 show that for a farmer who belongs to a farmer club the relative risk for using technologies would increase by a factor of (2.1727) in times of drought relative to doing nothing, given that other variables in the model are held constant. This shows that belonging to a farmer club increases the probability of using technologies to adapt towards droughts.

Effects of available labour hours on the choice of using of technologies as adaptation strategy for droughts. Adoption of new technology to adapt to climatic shocks requires a well-balanced amount of farm household labour to cover all the available farm operations. Results in Table 1 show that if a farmer is to increase their household labour supply by one unit the relative risk for using technologies to adapt to drought would change by a factor of 0.997 relative to doing nothing, given that other variables in the models are held constant. These results imply that if the household are hit by drought, they will be indifferent between either using technologies or doing nothing.

Effects of farmer capital on the use technologies as adaptation strategy for droughts. Farm capital ensures that all the farm operations are running smoothly. The results from Table 1 shows that, in times of drought, if a farmer is to increase their farm capital by one unit the relative risk for using technologies relative to doing nothing would change by a factor of (1.000) given that other variables in the model are held constant. This implies that the farmer would be indifferent between using a technology and doing nothing when hit by drought.

Effects of time floods occurred in the past ten years on the use of technologies as adaptation strategy for droughts. It is hypothesized that increase in number of times a shock occurred will increase farmers experience to deal with that shock. Results from Tables 1 indicate that if frequency of drought increases by one unit, the relative risk for using technologies relative to doing nothing would either decrease by a factor of (1.2531) given that other variables in the model

are held constant. The results imply farmers will prefer to use technologies when frequency of drought increases.

Effects of duration of climatic shock on the choice of using technologies as adaptation strategy for droughts. If farmer's exposure to droughts increases by one unit, the relative risk for using technologies relative to doing nothing would increase by a factor of (1.4656) given that other variables are held constant. The results imply that increase duration of the droughts would significantly ($P < 0.01$) increase the chance of using a technology to adapt to drought.

Effects of geographical location on the choice of using technologies as adaptation strategy for droughts. A previous study in the Nile basin, Ethiopia indicated that farmer's adaptation to climate variability is influenced by geographical location (Yesuf *et al.*, 2008). Results from this study shows that if a farmer belongs to the medium relative to low altitude areas the relative risk for using technologies relative to doing nothing in time of drought would increase by a factor of (2.3093) given that other variables in the model are held constant. Results of this study indicate that farmers located in medium altitude are more likely do nothing when hit by drought.

Effects of risk attitude on the choice of using technologies as adaptation strategy for droughts. The importance of risk attitude has been explained in the choice of adaptation strategies for mitigating climate risks. Results in Tables (1) show that, for a risk averse relative to a risk seeking households, the relative risk for using technologies relative to doing nothing would be expected to increase by a factor of (2.8497) in times of drought, given that other variables in the model are held constant. The results imply that when risk averse farm households are hit by drought, they would prefer to use technologies to mitigate to the shocks relative to doing. This clearly indicate that risk averse farmers opt for strategies that are sustainable to ensure continuous supply of food for their livelihood.

Conclusion

Decision to choose an adaptation strategy varied amongst different types of smallholder farmers within the study areas but this is compounded by dearth of human and technological capabilities to mitigate and adapt to the effects of climate variability. Among the adaptation strategies observed were the use of technologies, labour supply, reducing food consumption and savings. The use of pre-adaptation measures (technologies) was more preferred by risk averse households as opposed to the post-adaptation measures (savings and reduction in food intake) used by the risk seeking households to adapt to floods. A combination of pre-and post-adaptation measures (technologies and saving) was observed for risk averse households that were hit by drought as opposed to only savings by the risk seeking households. The findings show that the choices of adaptation strategies to climatic shocks are similar across the study regions. However, significant factors influencing the responses are not the same. Despite the differences in the choice of adaptation strategies between floods and droughts victims, the results pointed out the importance of frequency and duration of shocks, agro-ecological zone, and risk attitude of the household decision maker.

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