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Factors explaining farm households' access to and utilization of extreme climate forecasts in Sub-Saharan Africa (SSA)

Abstract

Climate change poses significant threat to African agriculture. This study analyzes the factors influencing access to and utilization of extreme weather forecasts in selected SSA countries. The data were collected from nine African countries and analyzed with descriptive statistics and probit regression. The results showed access to climate forecast was higher in East African countries where 65.95% received information on extreme climatic events. Majority of the farmers with access to climate information also received advice on its utilization. The main changes effected in farming systems due to forecast received included changes in the timing of farming activities, land management, crop planted and crop variety planted. Probabilities of access to and utilization of climate forecasts significantly increased ($p < 0.10$) with primary, secondary and tertiary education, among others. Initiatives that enhance farmers' literacy, access to radio and ability to observe accurately changes in weather would further enhance their adaptation through climatic forecasts.

Keywords: climate change, adaptation, climate forecast, East Africa, West Africa, Sub-Saharan Africa.
JEL Classification: Q5, Q54, Q540, Q580.

Introduction

Agriculture is the backbone of several African economies. Though dominated by peasant farmers, the African agriculture accounts for about 25 percent of the Gross Domestic Product (GDP) (Schaffnit-Chatterjee, 2014) and contributes about 60 percent of the labor force (Diao, 2007). As a primary supplier of raw materials, agriculture obviously defines the pathways for sustainable industrial growth and economic transformation of several African economies. Therefore, African nations cannot downplay the role of the agricultural sector given the problem of food insecurity, poverty and some other pressing socio-economic challenges (FAO, 2009; Schaffnit-Chatterjee, 2014).

However, climate change is now one of the major challenges of sustainable agricultural production in many African countries. This is obviously a form of market failure, and a pressing issue of concern for African policy makers. Climate change affects farming activities in several ways. These include rainfall instability, flooding, drought, extremely high or low temperature and severity of wind storms. Specifically, it had been estimated that in West Africa, 75 percent of economically active population is engaged in rain-fed agriculture [Food and Agricultural Organization of the United Nations (FAO), 2009]. This farming system exhibits significant vulnerability to climate change (Tall et al., 2012). Furthermore, ignoring warnings from international stakeholders on the efforts towards climate change mitigation is a time bomb, whose consequences could result in complete disruption of human ecological habitat. This is clearly evident from seriousness of projected impacts of climatic changes on welfare of farm households and African economic development at large.

Several authors have noted that variability in average temperature and precipitations portends some catastrophic consequences for African food situation given existence of underdeveloped irrigation schemes, low adoption of conservation agriculture and other pressing agricultural development constraints (Boko et al., 2007; Christensen et al., 2007; Müller et al., 2011; Waha et al., 2013). Reduction in the length of growing seasons due to erratic nature of rainfalls had been projected (Thornton et al., 2006), although felt impacts across African countries would differ based on resilience of cropping systems and adaptability of crop's genetic composition to projected variability (O'Brien et al., 2000; Thomas et al., 2007). Boko et al. (2007) also noted that Africa exhibits the highest vulnerability to climate change given that average temperatures would increase by between 1.5-4ºC and projected yields and revenues would by 2100 reduce by up to 50% and 90%, respectively. Furthermore, it was noted that by 2100, between 2-7 percent of agriculture's contributions to Gross Domestic Product (GDP) would be lost in the Sahara, 2-4% in Western and Central Africa and 0.4-1.3% in Northern and Southern Africa (Boko et al., 2007).

The need for climate change adaptation by small-scale farmers is therefore being emphasized in many international forums. The major intention is to fathom a development process that minimizes farmers' vulnerability to climate-related production risks. This is a critical step for objectively evaluating efficiency of nationally defined adaptive measures for climate change impact mitigation, given some peculiar uncertainties surrounding compliance with international commitments to reduce emission of greenhouse gasses (GHG) (World Bank, 2012). Obviously, adaptation initiatives frequently task food policy makers with urgent responsiveness to alternative management and policy options for defining optimum pathways to understand the interconnectedness of the social systems and some environmental parameters (Sarewitz et al., 2003; Pielke, 2007; Eakin and Patt, 2011). In Africa, more emphases are now placed on efficient adaptive mechanisms given the magnitude of climate change's projected impacts and inability to fully comprehend vulnerability in a society where institutional arrangements for mitigation are either deficient or completely lacking (Hinkel, 2011; Downing, 2012; Wise et al., in press).

Policy makers' have considered several alternatives for enhancing farmers' adaptive capacity in the face of changing climatic parameters. One of the strongly emphasized means for achieving this is provision of climate forecasts in order to enhance their preparedness for some changes in weather parameters. Therefore, the issue of access to climate forecasts is of tremendous significance in environmental literature. Such studies are useful because they define some socio-economic contexts within which farm households could be reached with necessary climate information. It is a form of risk management because it utilizes knowledge and information on the past climatic trends and events to make some reasonably reliable forecasts and projections of future climatic changes. Some studies have noted that on rainfall forecasts, there are some uncertainties in respect of reliability which are not likely to be addressed very soon (Stainforth et al., 2007; Koutsoyiannis et al., 2008, 2009; Kiem and Verdon-Kidd, 2011; IPCC, 2012).

In many developing countries, ability to provide accurate climate projections offers significant benefits to farm households although more frustrations are often experienced due to inaccessibility of climate forecasts or their existence in formats that cannot be perfectly decoded by largely illiterate farmers (Kiem and Austin, 2013). The overall usefulness of climate forecast is therefore determined by several factors. Firstly, the farmers must have access. Secondly, there must be sufficient ability to decode climatic forecasts. Finally, there must be sufficient motivation to effect changes in their production systems in line with the dictates of the forecasts. Although some authors have provided empirical evidences on usefulness of climate forecasts especially in regions that are highly vulnerable to some environmental disasters (Patt and Gwata, 2002; Ziervogel & Calder, 2003), there are also evidences that climate forecasts may be under-utilized thereby reducing the expected total utility (Pulwarty and Redmond, 1997; Pffaf et al., 1999; Bohn, 2003).

An area of research that needs to be further investigated is the extent to which farm households, as illiterate as majority could be can benefit from climate forecasts (Blench, 1999; Hudson and Vogel, 2003). Therefore, in the wake of recent environmental disasters, research activities that provide some adaptive responses to global environmental changes are now of very high priority. This is the gap that this study seeks to fill by analyzing the factors influencing access to climate forecast and determining how best those forecasts were utilized among some African farmers. The findings from the study will inform some policy initiatives to better channel climate forecasts in a manner that produces the ultimate expected impacts.

1. Conceptual framework

The framework for analyzing access and utilization of climate forecast begins by emphasizing that farm households can be irrational thereby unable to optimize returns from their decision making processes (Ziervogel, 2004; Clark and Marshall, 2002). This framework assumes that there are significant differences in the decisions that farm households would make under some scenarios of climatic changes (Weber and Sonka, 1994). Ziervogel (2004) described the premium upon which such decisions are based as "bounded rationality" due to non-existence of perfect knowledge. It is a form of decision that is made based on some uncertainties, and is directly influenced by their cognitive capacity (such as educational attainments, indigenous knowledge, etc.), available resources (such as income, credit, etc.) and environmental factors (Simon, 1957).

In Figure 1, Fischhoff (1994) explained the processes of climate information dissemination which begins at information delivery. At this stage, access to the information is informed by drive for information seeking and the extent of network formed with other people in the society. At the second stage, external and internal filters are integrated into defining the usefulness of the information. Such filters may be internal or external in nature. External filters are judgment of other community members on the importance of the forecast and availability of resources to take necessary actions, while internal filter are directly related to farm households' production/consumption preferences and ability to perceive the usefulness of the forecast and associated risks. Stage three is where decisions on adaptation are taken while the impacts are reflected in stage four.

Definitely, several demographic and socio-economic factors are at the forefront of farmers' decision on climate adaptation. While some farmers are risk takers, others can be risk averse. In literature, the 'prospect theory' established that there are differences in the way expected gains and losses from decision would be viewed with greater reliance on heuristics factor (Kahneman and Tversky, 1979). Similarly, the risk preference of individuals is related to their wealth, educational attainments or age among other factors

(Weber and Sonka, 1994). It may also reflect long term perspectives of individual farmers in their farming objectives. No doubt, therefore, the timing of climate forecasts would go a long way in their usefulness. Quoted by Ziervogel (2004), farmers "do not simply respond to exogenous and endogenous change reactively within each growing season. Their decisions, when considered in sequence, are cumulative and purposive and have, therefore, a longer term significance which reflects their understanding of longer term and larger scale changes" (Adams and Mortimore, 1999, p. 10).

Some authors have hinted that in the event of risks and uncertainties, farm households do adjust their production activities in order to exploit some market liberalization opportunities (Delgado and Siamwalla, 1997; Barrett et al., 2001; Carter, 1997). Such adjustments will affect the level of income, its distribution and poverty level (Ellis, 1998, 2000; Hoogeveen, 2001; Reardon et al., 2000). In a study carried out in Lesotho, Ziervogel (2004) found that it would be the last resort for farmers to sell their livestock during drought since it symbolizes their wealth (Ferguson, 1985). The response of the farmers to forecast will depend so much on the lead time and their adaptive capacity. While shorter lead time guarantees better accuracy, it does not guarantee access to adaptation initiatives.

Although some authors have highlighted the need for ensuring adequate regional factors in recommending specific strategies for farmers' climatic change adaptation (Lobell et al., 2008), low educational attainments are often major hurdles for climate change mitigation among African farmers. More precisely, low attainment of formal education is often seen as a major hurdle for adoption of innovations and utilization of emerging agricultural development opportunities among African small scale farmers.

Tall et al. (2012) noted that climate forecasts had been previously underutilized for several reasons. These include lack of existence of information gap between critical stakeholders in the use of climate forecasts, cultural barriers reinforced by difficulties in changing from a mindset of disaster response to preparedness and early action, lack of sufficient funding from donor agencies, too much technicality attached to provided forecasts which limits ability of final users to properly decode them, and non-salience and reliability of provided information. The above issues emphasize the fact that in many instances, despite some previously relayed climatic forecasts, preparedness of people to ensure mitigation of any welfare losses as a result of climatic hazards is often limited (Suarez, 2009; Tall et al., 2012). Patt and Gwata (2002) found that among the factors that limited utilization of climatic forecasts among some Zimbabwean farmers included lack of trust in the messages and messengers, inability to provide information on specific location, inability to understand the key messages in the provided forecasts and non-timeliness of the forecast.

In some empirical studies, several studies have highlighted the role of education in adapting to climatic changes (Maddison, 2006). Deressa et al. (2009) found that in Ethiopia, household heads' educational attainments increased significantly the probabilities of engaging in soil conservation and changing planting dates due to climatic changes. In semi-arid parts of Kenya, Githungo et al. (undated) found that climate forecasts were not well understood by farmers, thereby limiting their intended usefulness. Due to low educational attainments, farm households do not possess the requisite capacity for interpreting and using weather forecasts. This necessitates dissemination of climatic forecasts in a manner that can be easily interpreted and used by illiterate farmers.

2. Materials and methods

2.1. The study area. The data were collected by the research program on Climate Change, Agriculture and Food Security (CCAFS) as baseline climate change survey. The respondents were farm households randomly selected from some locations in selected countries in East and West Africa. The data were collected between late 2010 to early 2011 (Climate Change Agriculture and Food Security, 2014). In East Africa, the selected sites were Ethiopia, Kenya, Tanzania and Uganda from which 140, 139, 140 and 280 farmers were sampled respectively. In West Africa, however, five sites comprising Burkina Faso, Ghana, Mali, Niger and Senegal were selected from which 140, 140, 141, 140 and 140 farm households were sampled respectively. In all, a total of 1398 farm households were sampled from the two subregions. Information collected included observed forms of climate change, monthly food shortages, monthly contribution of home-produced food to food intakes, adoption of soil conservation practices, available forms of rural livelihoods, socio-economic characteristics of households and climate adaptation options, among others. Some other details in respect of the selected enumeration areas and procedures for sampling were described by Kristjanson et al. (2012).

2.2. Model specification. Probit regression method was used to analyze the factors influencing access and utilization of climate forecasts due to the dichotomous nature of the dependent variable. In this case, access to climate change was coded 1 if a farm household had access and 0 otherwise. Similarly, households that were able to take definite farming decision due to received climate forecasts were coded 1 and 0 otherwise. Probit modeling uses the Maximum Likelihood Estimates (MLE) for estimating the parameters of the variables due to econometric deficiency in results that would be obtained when Ordinary Least Square (OLS) is used. Precisely, Probit model is based on latent model which can be expressed as:

$$P\left(\left(Z_i = 1 \middle| x\right) = \left(z_i^* > 0 \middle| x\right)\right), \quad (1)$$

$$= P\left(x_i' + \varepsilon_i > 0 \middle| x\right), \quad (2)$$

$$= P\left(\varepsilon_i > x_i' \beta \middle| x\right), \quad (3)$$

$$= 1 - F\left(x_i' \beta\right). \quad (4)$$

The error terms are normally distributed and independent, therefore:

$$P\left(z_i = 1 \middle| x\right) = 1 - \phi\left(-\frac{x_i' \beta}{\sigma}\right), \sigma \equiv 1, \quad (5)$$

because of symmetry assumption:

$$1 - \phi\left(-\frac{x_i' \beta}{\sigma}\right) = \phi\left(x_i' \beta\right). \quad (6)$$

The marginal parameters represent the effect of a unit change in an independent variable on the probability $P\left(Z = 1 \middle| X = x\right)$ given that all other variables are held constant. These can be computed from some econometric software like STATA. It is mathematically expressed as:

$$\frac{\delta P\left(z_i = 1 \middle| x_i\right)}{\delta x_i} = \frac{\delta E\left(z_i \middle| x_i\right)}{\delta x_i} = \varphi\left(x_i' \beta\right)\beta, \quad (7)$$

z_i is the dependent variable and x's are the independent variables with their descriptive statistics presented in Table 1 (see in Appendix).

3. Results and discussions

3.1. Socio-economic characteristics of the farmers. The results in Table 1 show the descriptive statistics of the respondents. It reveals that average household size was higher in West Africa with 12.72 members as against 6.24 in East Africa. Average dependencies with respect to the number of household members less than five years and more than 60 years were higher in West Africa. These results are to be evaluated in the light of the fact that in some rural areas, household members constitute essential family labor, although returns per member are often smaller thereby making poverty to be largely associated with large family sizes [International Fund for Agricultural Development (IFAD), 2001]. High number of dependants also constitute serious burden since people in that group contribute less to farm activities.

Furthermore, the table shows that about one-half of farm households reported to have attained primary education. Secondary and tertiary educational attainments were more reported in East Africa. Majority of the farm households had lived in the villages for more than 10 years. With 5.54 hectares and 1.08 hectares, average owned cropland and degraded lands were higher in West Africa. The sources of incomes for farm households are presented in Table 1. The results show that 41.77% of the households from West Africa generated incomes from employment on other people's farms, as against 37.20% in East Africa. Business was a source of income for many households in East and West Africa though participation was higher in the latter.

More households from West Africa had access to bank loans and informal loans than those from East Africa. Specifically, in both regions, less farmers could access bank loans than they did for informal loans. In West Africa, 46.64% got informal loans, compared to 17.02% for formal (bank). Furthermore, remittances were received by 36.05% of households from East Africa, as against 25.61% from West Africa.

The table also presents ownership of assets by rural households. Ownership of radio was reported by 83.40% and 69.24% of the farmers from West and East Africa, respectively. However, television was each owned by 6.01% of the households in West and East Africa. Also, 68.53% and 52.93% of the households from West and East Africa respectively owned cell phones. Recent economic transformation in many African countries is in the telecommunication sector where mobile technologies are transforming the business atmosphere with utmost efficiency. Low economic status, coupled with the nature of the road networks in rural areas often encourages the use of bicycle and motorcycle by the residents. In the results, 59.66% of farm households from West Africa owned bicycles, while about one-quarter owned motorcycles. In East Africa, 33.76% and 7.87% of the households respectively owned bicycles and motorcycles.

3.2. Observed forms of climate change. The results in Table 1 show that in West and East Africa, 73.96% and 71.95% of the farmers respectively experienced one form of climatic shock or the other in the previous five years before the survey.

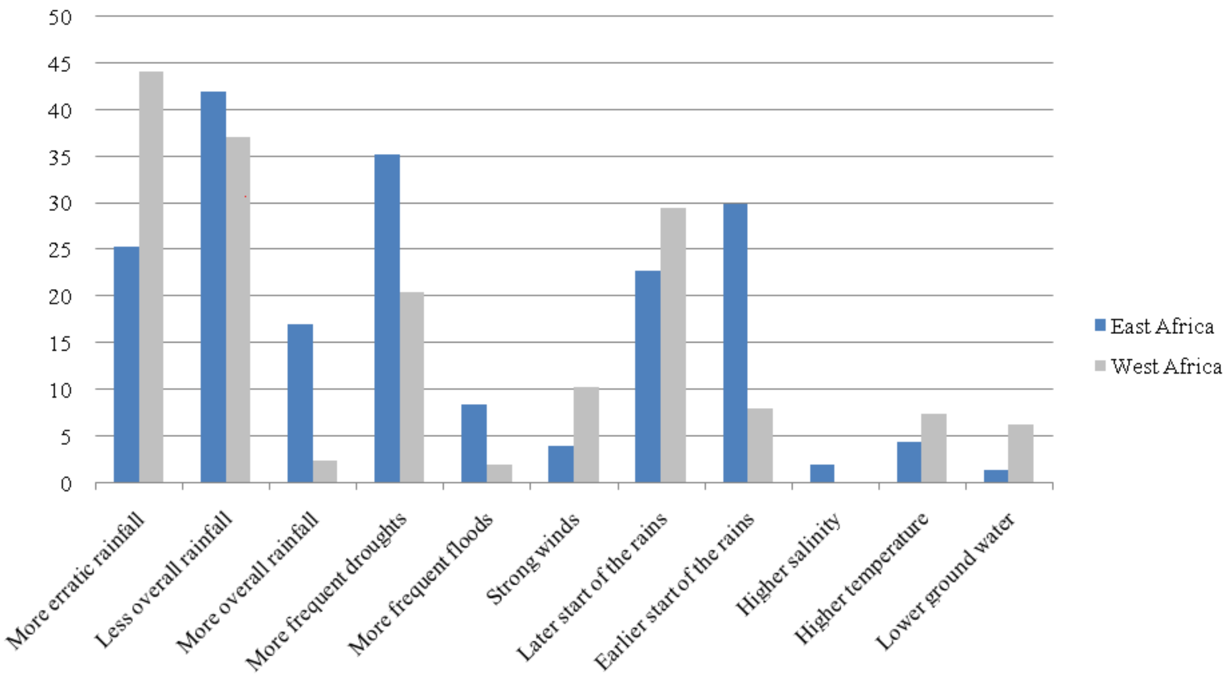

Fig. 1. Observed forms of climate change by the farmers

Figure 1 shows that erratic rainfall was reported by more farmers from West Africa, while less overall rainfall was reported by more households in East Africa. More overall rainfall and more frequent droughts were reported in East Africa. Other forms of climate change with serious implication for farming activities are late or earlier commencement of rainfall which were reported by 22.75% and 29.90% of the households in East Africa.

These results are amplifying concerns from policy makers on recent instability in some climatic parameters in many African countries. The climatic transition underscores some notion of oblivious tenacity in several anthropogenic and production processes that transmit into climate changes. Given such changes in climatic parameters, some coping options in the form of assistances rendering during periods of shocks have been implemented at national and international levels. However, the results show that 20.02 percent of the farm households in East Africa indicated to have received such assistances during climate-related shocks as against 17.31% in West Africa.

3.3. Access to climate forecasts. The distribution of the farmers in relation to climate forecasts' access is presented in Table 2.

Table 2. Percentage distribution of households' access to climate forecasts

Variables	East Africa	West Africa
Information received		
No	34.05	56.94
Yes	65.95	43.06
Person that received information		
Men	24.61	28.18
Women	15.31	0.86
Both	26.04	13.88
No response	34.05	57.08

In Table 2 it reveals that access to climate forecast was generally higher in East African countries than West Africa. Specifically, in East Africa, 65.95% of the farm households received information on extreme climatic events. Kiem et al. (2011) highlighted the need to assist farm households with climate forecasts and projections that are accurate and reliable. Specifically, policy makers' efforts at ensuring adequate preparedness for climatic changes require that there is sufficient participation by users in order to ensure that disseminated information achieves the desired targets (Romsdahl and Pyke, 2009). This then calls for understanding the role of each gender in fostering the processes of climate information dissemination. The results showed that highest proportions of the persons that received the climate forecast information were men in East and West Africa. Similarly, more women got information in East Africa (15.31%) than

West Africa (0.86%). In some reported cases, both genders received climate forecast information with 26.04% and 13.88% in East and West Africa, respectively. These results are further emphasizing critical roles that all stakeholders need to perform in order to ensure that climate change forecasts reach specific audiences with utmost feedbacks and impacts (Bartels et al., 2012; Dilling and Lemos, 2011).

Figure 2 reveals that radio was the highest source of climate change information with 53.22% and 36.62% in East and West Africa, respectively. In many rural areas in Africa, radio is the primary source of information on government economic development projects, policies and other political issues. Due to its wider coverage, radio is often chosen as means of disseminating information to local farmers. Climate forecasts in this case are not exceptions. The results show that information on extreme climate events was also obtained from friends by 17.60% and 15.45% of farm households from West and East Africa, respectively. Good interactions often exist among farmers which make information sharing a commitment, especially when it is seen as a collective responsibility to avert production losses from an imminent risky situation.

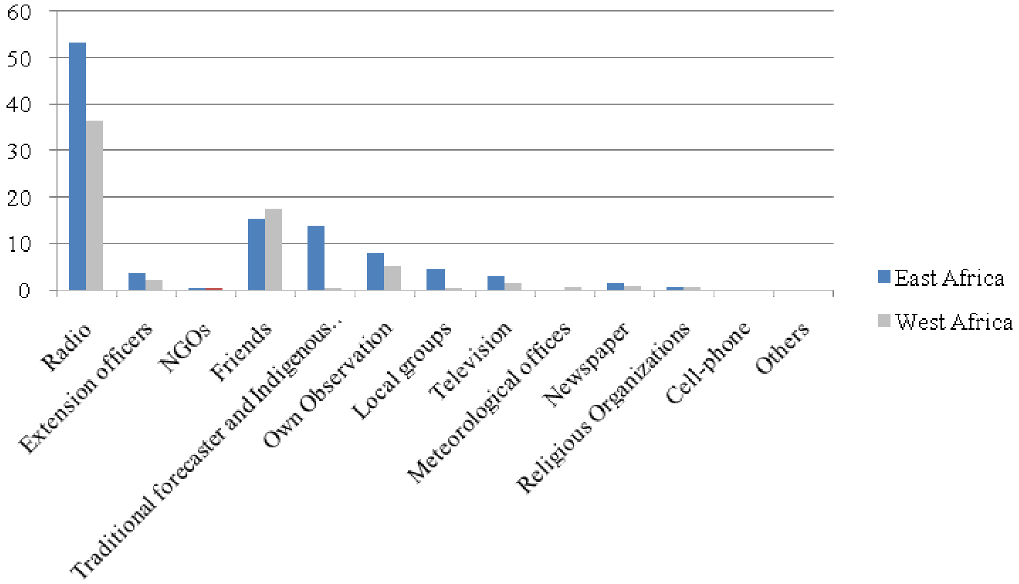

Fig. 2. Sources of climate change information

Table 3. Percentage distribution of inclusion of advices in climate forecast

Nature of forecast	East Africa	West Africa
Forecast included advice		
No	20.17	10.9
Yes	45.35	32.0
No response	34.48	57.1
Able to use advise		
No	6.29	8.6
Yes	38.91	23.6
No response	54.79	67.8

3.4. Advices received with climate forecast by the farmers. The results in Table 3 further indicate that majority of the farmers with access to climate forecast also received necessary advice on its usefulness. Majority of the farmers that received advice on climate change could use them for definite changes in their farming systems. Figure 3 shows that the main changes effected in farming systems due to climatic forecast and advice included changes in the timing of farming activities, land management, crop planted and crop variety planted. However, no farmer in West Africa could respond to climate forecasts by taking some farming decisions in relation to irrigation and livestock feed management.

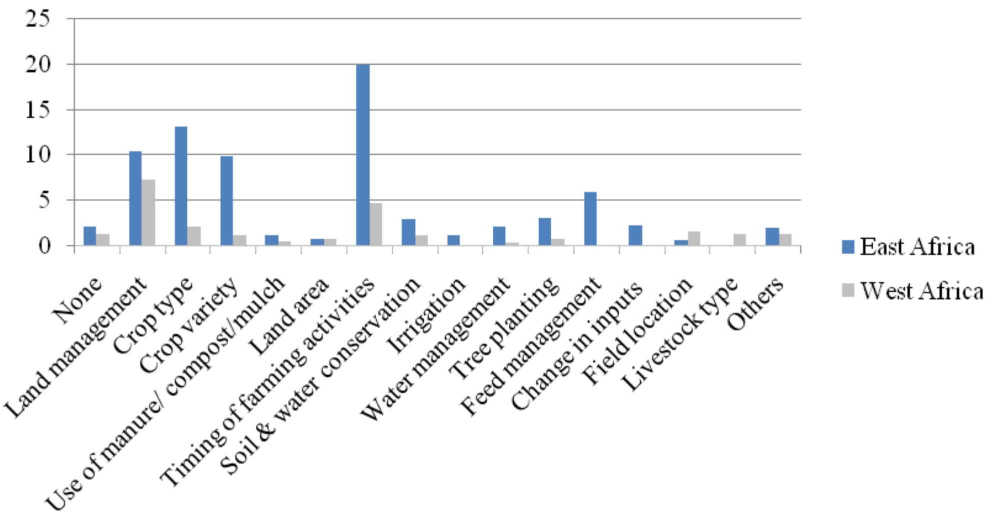

Fig. 3. Changes effected in farming practices due to climate change advice received

Probit regression results

Table 4 (see in Appendix) shows the results of the Probit regression which determined the factors influencing access to and utilization of extreme climate forecasts. The results for standard Probit regression and marginal parameters were presented. The results show that the models produced good fits for the data as revealed by statistical significance of the Likelihood Ratio Chi Square ($p < 0.01$) statistics ($p < 0.01$). The marginal parameters were however used for interpretation of the results.

Table 4 shows that farmers from Burkina Faso had probabilities of having access to extreme climate forecast and its utilization reduced by 0.2342 and 0.1212 compared to those from Uganda. However, compared with those from Uganda, farm households from the selected villages in Ethiopia had their probabilities of having access to and utilization of extreme climate forecast increased and reduced by 0.1752 and 0.1120, respectively. While the parameter for Kenya in the utilization model was statistically insignificant ($p > 0.10$), the access parameter implies that compared to Ugandan farmers, Kenyan farmers had their probability of having access to extreme climate forecast significantly increased by 0.1983 ($p < 0.01$). The estimated parameters for Mali implied that access to and utilization of extreme climate forecasts significantly reduced by 0.1864 and 0.1658 ($p < 0.01$) respectively when compared with farmers from Uganda. Similar fin-ding was in the results for Niger and Mali where compared to Uganda, farmers in those countries had significantly lower probabilities of having access to and utilizing extreme climate forecasts ($p < 0.05$). However, while the parameter for Tanzania in the access model showed no statistical significance ($p < 0.10$), farmers in Tanzania had their probability to utilize forecast of extreme climate events significantly increased by 0.2811 ($p < 0.01$).

The parameters of owned cropland and owned degraded land were statistically insignificant ($p > 0.10$). However, those for the rented degraded land in the access and utilization models implied that if degraded land area increased by one hectare, probabilities of utilizing extreme climate forecast significantly increased by 0.1621. Land, as the primary input for agricultural production now suffers from persistent degradation in many African countries. If it is not available in sufficient and quality forms, agricultural development will be impeded. Therefore, coupled with climate change, African farmers often struggle with enhancing crop productivity on land resources that are of rapidly declining productivity.

The parameter of household size in the access model indicated that if household size increased by one person, the probability of having access to climate forecast significantly decreased by 0.0090 ($p < 0.05$). However, utilization probability decreased significantly ($p < 0.10$) by 0.0062 if the household size increased by one person. Also, as the number of household members that were less than five years increased by one person, probabilities of utilizing forecasts of extreme climatic events significantly increased by 0.0210 ($p < 0.05$). Households with large size may have surplus labor to engage on other people's farms or engage in other forms of livelihoods. The premise for adapting to climate change may also be defined from ability to provide required farm labor for adjusting to production systems.

All the education variables were with positive sign. The results showed that compared with households that had no education, probabilities of having access to and utilization of forecasts on extreme climate events significantly increased by 0.0821 ($p < 0.10$) and 0.1290 ($p < 0.01$) respectively with primary education. Similarly, when compared with those without formal education, with attainment of secondary education, probabilities of having access to and utilization of extreme climate forecasts significantly increased by 0.1169 ($p < 0.05$) and 0.1577 ($p < 0.05$), respectively. Attainment of tertiary education significantly increased ($p < 0.05$) the probabilities of utilizing climate forecast by 0.2180 when compared with households without formal education. These results are expected judging from findings from some previous studies (Maddison, 2006; Deressa et al., 2009; Githungo et al., undated).

The results in Table 4 further showed that compared with those without opportunities of being employed on other people's farms, households with opportunities of generating incomes from employment on other people's farms had their probabilities of having access to climate forecasts and utilization significantly increased ($p < 0.01$) by 0.0919 and 0.1127, respectively. Furthermore, compared to households without access, paid employment significantly increased the probability of having access to extreme climate forecast by 0.1474. Also, compared to those without access, business income significantly increased probabilities of having access to extreme climate forecast and utilization of the forecast by 0.1149 ($p < 0.01$) and 0.0525 ($p < 0.010$), respectively. Ability to engage in several means of livelihoods is essential for coping under risky production environment (Delgado and Siamwalla, 1997; Barrett et al., 2001; Carter, 1997). Consumption smoothing is the goal although this operates by its influence on households' income and poverty level (Ellis, 1998, 2000; Hoogeveen, 2001; Reardon et al., 2000).

In addition, compared with those without access, informal loan significantly increased the probability of having access to climate forecast by 0.0936 ($p < 0.05$). Access to credit is not only critical for income generation in many African rural areas, it can also guarantee minimum welfare losses in times of income risks exposure. In a previous study, Di Falco et al. (2011) found that provision of adequate access to credit positively influenced probability of climate change adaptation in Ethiopia.

The results in Table 1 further reveal the impacts of climate shock exposure and the perceived forms of climate changes on access and utilization of climate forecasts. It shows that farm households that indicated to have been exposed to some climatic shocks had their probabilities of having access to and utilization of climatic forecasts significantly increased ($p < 0.01$) by 0.2875 and 0.0843, respectively. The parameters of receiving assistance during shock indicated that compared with those that answered no, being able to receive assistances during climatic shocks significantly increased the probabilities of having access to climatic forecasts and utilization of them by 0.1260 ($p < 0.01$) and 0.0932 ($p < 0.05$), respectively. These results are expected because it is often said that "once beaten twice shy". Farmers that had suffered welfare losses from climatic changes would often seek information on future climatic occurrences in order to plan ahead.

The farmers that perceived more overall rainfall had probability of using climate forecast significantly increased by 0.1293 ($p < 0.05$). Similarly, those that perceived more frequent droughts had their probabilities of having access to climate forecast and utilizing them significantly increased by 0.1078 ($p < 0.01$) and 0.0640 ($p < 0.10$), respectively. The farmers that perceived late start of rainfalls had probabilities of having access to climate forecast and utilizing them significantly increased ($p < 0.01$) by 0.1477 and 0.2043, respectively. Similar results were obtained for higher salinity and temperature, where their perceptions significantly increased access to climate forecast and utilization ($p < 0.05$) by 0.2951 and 0.1743, respectively.

Access to radio significantly increased ($p < 0.01$) probabilities of having access and utilization of climate forecasts on extreme events by 0.1249 and 0.1156, respectively. Radio and television are sources of information. In some African rural areas, lack of electricity supply often limits the use of electrical gadgets. Radio usage can be very common due to low cost of maintenance from low voltage batteries. It is therefore expected that majority of the farmers had radio. Ownership of motorcycle also significantly increased probabilities of having access and utilization of climate forecasts on extreme events by 0.1278 and 0.0866, respectively.

Comparison across the gender of who received the information showed that compared to cases where both genders received the information, households where men alone and women alone received climate information had probabilities of utilizing them significantly increased ($p < 0.01$) by 0.3087 and 0.2147, respectively. These results are emphasizing gender neutrality in access and utilization of climate forecasts, although more impact would be felt if male farmers are targeted.

Conclusion

Climate change poses serious threats to agricultural growth and development in many African countries. This paper analyzed the factors climate change impact mitigation via climate forecast information seeking and utilization in selected SSA. The study concludes that farmers were seeking climate forecasts as integral elements of their farm decision making and attempts to promote this avenue for adapting to climatic changes should focus on some of the following: Promote some informal education among illiterate farmers in order to facilitate their climate information seeking behavior and utilization. Such education can also assist them in taking critical decision in respect of family size given declining fertility status of their land resources. However, efforts to promote technological innovations that would reduce labor demand of peasant farmers which often makes them demand high family size should be encouraged. Large family size aggravates the impact of climate change due to high food requirements.

Similarly, there is the need to build the capacities of rural households for livelihood diversification. This can be facilitated by organizing trainings on alternative income generation activities they can engage in order to offset the impact of climate change on their crop production activities. Precisely, such livelihood would be better enhanced if low interest loans are accessible to farmers. This is vey critical given that the findings have shown low access to formal loan by farmers from both countries.

Furthermore, there should be more integration of daily, weekly and monthly climate forecasts into radio and television programs. This is a critical need among farmers in West Africa where access to climate forecast was found to be low. Such forecasts should be directed at both male and female farmers, and should clearly indicate what farmers are expected to do and the implications of being lackadaisical. Extension agents should also be alerted about issues related to climate change and disseminate such media information to farmers within their reach. However, there should be adequate mechanisms to reduce vulnerability of farmers to climatic shocks. This is needed in order to respond quickly to the need of climatic shock affected people, especially those in rural areas.

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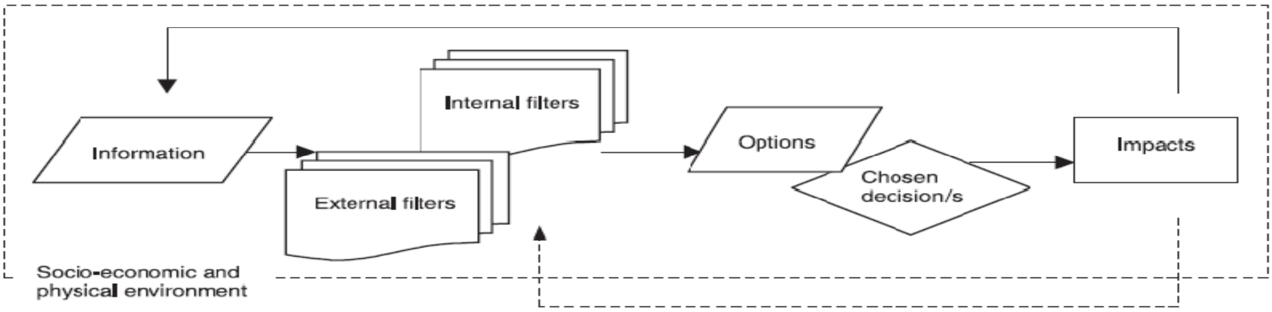
Appendices



Step 1	Step 2	Step 3	Step 4
Dissemination effectiveness depends on	Integration of information based on filters	Decision option	Type of impact
Method (radio, print media, personal communication); Timing; Creditability.	External: Suitable scale for response; Other households' responses; Availability of resources. Internal: More adverse to perceived loss than gain; Fit with endogenous knowledge; Perceived available options; Past experience.	Alter crop management; Alter livestock management; Alter natural resource management; Alter household decisions. (Data from role play)	Positive impact; Negative impact; No impact; Impact determines past experience filter the following year.

Source: Ziervogel, 2004.

Fig. 1. Framework for assessing how forecast information is integrated into farm decision processes

Table 1. Descriptive statistics of farmers' socio-economic characteristics and climatic shocks exposure

Variable			Mean	Std. dev.	Mean	Std. dev.
	Type of variable	Unit	East Africa		West Africa	
Sources of land						
Personal land (ha)	Continuous	Ha	2.83	3.11	5.54	9.73
Personal degraded land (ha)	Continuous	Ha	0.25	0.92	1.08	1.93
Rented degraded land (ha)	Continuous	Ha	0.00	0.08	0.02	0.26
Climate shock						
Climatic shocks exposure	Dummy	%	71.95	0.45	73.96	0.44
Received help for shocks	Dummy	%	20.02	0.4	17.31	0.38
Demographic characteristics						
Household size	Continuous	Numeric	6.24	3.18	12.72	9.78
Household less 5 yrs	Continuous	Numeric	1.38	1.4	2.61	2.66
Household more 60 yrs	Continuous	Numeric	0.38	0.66	0.94	1.01
Primary education	Dummy	%	51.79	0.5	52.79	0.5
Secondary education	Dummy	%	29.61	0.46	21.32	0.41
Tertiary education	Dummy	%	8.87	0.28	1.29	0.11
Sources of income						
Farm employment	Dummy	%	37.2	0.48	41.77	0.49
Other paid employment	Dummy	%	18.03	0.38	16.88	0.37
Business	Dummy	%	34.48	0.48	47.07	0.5
Remittances or gifts	Dummy	%	36.05	0.48	25.61	0.44

Table 1 (cont.). Descriptive statistics of farmers' socio-economic characteristics and climatic shocks exposure

Variable			Mean	Std. dev.	Mean	Std. dev.
	Type of variable	Unit	East Africa		West Africa	
Sources of income						
Environmental services	Dummy	%	2.43	0.15	2.72	0.16
Projects/govt.	Dummy	%	6.87	0.25	15.02	0.36
Bank loan	Dummy	%	9.87	0.3	17.02	0.38
Informal loan	Dummy	%	17.17	0.38	46.64	0.5
Renting of machinery	Dummy	%	3.58	0.19	10.73	0.31
Renting out land	Dummy	%	5.58	0.23	3.86	0.19
Residence in location > 10yrs	Dummy	%	86.84	0.61	99.43	0.08
Form of climate change						
More erratic rainfall	Dummy	%	25.32	0.44	44.06	0.5
Less overall rainfall	Dummy	%	41.92	0.49	37.05	0.48
More overall rainfall	Dummy	%	17.02	0.38	2.43	0.15
More frequent droughts	Dummy	%	35.19	0.48	20.46	0.4
More frequent floods	Dummy	%	8.44	0.28	2	0.14
Form of climate change						
Strong winds	Dummy	%	4.01	0.2	10.3	0.3
Later start of the rains	Dummy	%	22.75	0.42	29.47	0.46
Earlier start of the rains	Dummy	%	29.9	0.46	8.01	0.27
Higher salinity	Dummy	%	2	0.14	0.14	0.04
Higher temperature	Dummy	%	4.43	0.21	7.44	0.26
Lower ground water	Dummy	%	1.43	0.12	6.29	0.24
Asset ownership						
Radio	Dummy	%	69.24	0.46	83.4	0.37
Television	Dummy	%	6.01	0.24	6.01	0.24
Cell phone	Dummy	%	52.93	0.5	68.53	0.46
Bicycle	Dummy	%	33.76	0.47	59.66	0.49
Motorcycle	Dummy	%	7.87	0.27	25.18	0.43
Motor car	Dummy	%	1.57	0.12	0.57	0.08

Note: dummy variables were estimated with yes response = 1 and 0 otherwise.

Table 4. Factors influencing farmers' access and utilization of extreme climatic forecasts

	Access model				Utilization model			
	Standard probit		Marginal paramters		Standard probit		Marginal parameters	
	Coeffi	z-stat	Coeffi	z-stat	Coeffi	z-stat	Coeffi	z-stat
Country								
Burkina Faso	-0.5983	-3.24	-0.2342	-3.41	-0.4931	-2.23	-0.1212	-2.74
Ethiopia	0.4683	2.67	0.1752	2.89	-0.4476	-1.89	-0.1120	-2.29
Ghana	0.0981	0.52	0.0384	0.52	0.2738	1.37	0.0867	1.28
Kenya	0.5365	2.78	0.1983	3.08	0.0812	0.43	0.0244	0.42
Mali	-0.4718	-2.64	-0.1864	-2.71	-0.7449	-3.39	-0.1658	-4.78
Niger	-0.4704	-2.46	-0.1858	-2.52	-1.4203	-4.35	-0.2403	-10.33
Senegal	-1.5481	-6.98	-0.5122	-11.36	-0.8859	-3.29	-0.1858	-5.13
Tanzania	0.2938	1.50	0.1128	1.56	0.8017	3.82	0.2811	3.47
Land owned								
Personal land (ha)	-0.0018	-0.27	-0.0007	-0.27	0.0014	0.20	0.0004	0.20
Personal degraded land (ha)	-0.0046	-0.17	-0.0018	-0.17	-0.0015	-0.05	-0.0004	-0.05
Rented degraded land (ha)	0.4039	1.95	0.1594	1.95	0.5535	2.77	0.1621	2.76
Demographic characteristics								
Household size	-0.0229	-2.56	-0.0090	-2.57	-0.0213	-1.93	-0.0062	-1.94
Household less 5 yrs	0.0471	1.58	0.0186	1.58	0.0719	2.09	0.0210	2.10
Household more 60 yrs	-0.0167	-0.33	-0.0066	-0.34	-0.0451	-0.79	-0.0132	-0.79

Table 4 (cont.). Factors influencing farmers' access and utilization of extreme climatic forecasts

	Access model				Utilization model			
	Standard probit		Marginal paramters		Standard probit		Marginal parameters	
	Coeffi	z-stat	Coeffi	z-stat	Coeffi	z-stat	Coeffi	z-stat
Demographic characteristics								
Primary education	0.2083	1.81	0.0821	1.82	0.4456	2.72	0.1290	2.78
Secondary education	0.3013	2.21	0.1169	2.27	0.4961	2.72	0.1577	2.56
Tertiary education	0.1707	0.80	0.0663	0.81	0.6282	2.46	0.2180	2.21
Residence in location > 10yrs	-0.0512	-0.46	-0.0202	-0.46	-0.0067	-0.07	-0.0020	-0.07
Sources of Income								
Farm employment	0.2343	2.69	0.0919	2.71	0.3744	3.90	0.1127	3.81
Other paid employment	0.3859	3.52	0.1474	3.69	0.1562	1.33	0.0475	1.28
Business	0.2935	3.33	0.1149	3.37	0.1771	1.81	0.0525	1.79
Remittances or gifts	0.0494	0.54	0.0195	0.54	0.1018	1.03	0.0303	1.02
Environmental services	0.4338	1.44	0.1615	1.58	-0.0151	-0.06	-0.0044	-0.06
Projects/govt.	0.0948	0.70	0.0372	0.70	0.0478	0.32	0.0142	0.31
Bank loan	-0.0265	-0.22	-0.0105	-0.22	0.0118	0.09	0.0035	0.09
Informal loan	0.2396	2.54	0.0936	2.57	0.0835	0.77	0.0247	0.77
Renting of machinery	-0.1702	-1.04	-0.0676	-1.03	0.1608	0.95	0.0495	0.91
Renting out land	-0.1269	-0.69	-0.0504	-0.69	0.2341	1.24	0.0740	1.16
Shock exposure								
Climatic shock	0.7372	7.43	0.2875	7.79	0.3054	2.54	0.0843	2.71
Assistance received for shocks	0.3273	2.80	0.1260	2.90	0.2977	2.35	0.0932	2.22
More erratic rainfall	-0.1408	-1.19	-0.0557	-1.19	-0.1501	-1.11	-0.0431	-1.13
Less overall rainfall	-0.1247	-1.04	-0.0493	-1.04	-0.1378	-1.01	-0.0399	-1.02
More overall rainfall	0.1004	0.64	0.0393	0.65	0.3959	2.53	0.1293	2.31
More frequent droughts	0.2772	2.48	0.1078	2.53	0.2111	1.78	0.0640	1.72
More frequent floods	-0.1163	-0.56	-0.0462	-0.56	-0.3764	-1.79	-0.0951	-2.12
Strong winds	0.1238	0.64	0.0484	0.65	0.2163	1.04	0.0678	0.98
Later start of the rains	0.3832	2.89	0.1477	3.00	0.6325	4.50	0.2043	4.19
Earlier start of the rains	0.0230	0.15	0.0091	0.15	-0.0207	-0.13	-0.0060	-0.13
Higher salinity	0.8989	1.50	0.2951	2.11	0.6642	1.51	0.2348	1.35
Higher temperature	0.2926	1.38	0.1120	1.44	0.5147	2.42	0.1743	2.19
Lower ground water	0.2489	0.87	0.0957	0.90	-0.2912	-0.99	-0.0760	-1.13
Asset ownership								
Radio	0.3150	2.86	0.1249	2.87	0.4356	3.13	0.1156	3.50
Television	-0.0065	-0.04	-0.0026	-0.04	0.3169	1.81	0.1023	1.67
Cell phone	0.1179	1.24	0.0466	1.24	0.0191	0.18	0.0056	0.18
Bicycle	0.2132	1.74	0.0839	1.76	0.1456	1.09	0.0428	1.08
Motorcycle	0.3327	2.53	0.1278	2.62	0.2766	1.99	0.0866	1.87
Motor car	-0.5467	-1.32	-0.2139	-1.40	-0.3953	-0.99	-0.0975	-1.21
Who received information								
Men					0.9307	8.68	0.3087	8.25
Women					0.6246	3.81	0.2147	3.43
Constant	-1.2519	-6.04			-2.3627	-9.19	-	-
Diagnostic statistics								
Log likelihood	-710.75				-540.24			
LR chi square (47)	499.08***				643.01***			
Pseudo R square	0.2599				0.3731			
					1393			