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Farmers' Perceptions, Exposure and Response to Climate Variability in Mwea, Kenya

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ABSTRACT

Climate variability is expected to have adverse effects on livelihoods in farming communities. A survey was carried out to establish the extent of farmers' knowledge and response to climate variability in Mwea, Central Kenya. A semi-structured questionnaire was used to collect data on household and livelihood characteristics through individual interviews. The stratified random sampling technique was used to sample 385 farmers. Results show that 75.3% of the respondents were aware of climate change. Thus 95.6% perceived changes in rainfall patterns while 98.3% ($p<0.001$) perceived changes in temperature. Rainfall variability was described as being more unpredictable (55.7%), decreased in days and amount (41.8%) while only 2.4% were of the opinion that it had increased. Temperature change was described as being hotter by 75.7% of the respondents; more unpredictable (21.9%) and 2.3% thought it had become cooler. This variability in climate influenced farming among 70.4% ($p<0.001$) farmers. Some of the coping strategies reported were early planting by 65.7% ($p<0.001$), planting different crops at the same time (24.6%) and planting different of crops at different times (9.6%). Drought was the main climate related risk experienced by 69.4% ($p<0.001$) of the respondents. There is need to improve awareness to climate variability and response strategies in this region.

Key words: Climate variability, Coping strategies, Drought, Temperature rise, Rainfall variability and Respondents.

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INTRODUCTION

Vulnerability to climate change is a function of exposure to climate stresses and the adaptive capacity to cope with these stresses (Ford and Smit, 2004; Schröter et al., 2005; Eakin and Luers, 2006; Heltberg et al., 2009). A study by Brouwer et al. (2007) in Bangladesh established a positive relationship between environmental risk, poverty and vulnerability in flood occurrences. This exposure to environmental risks was also shown to be related with income inequality and access to natural resources. A similar study by Ongoro and Ogara (2012) working in Samburu, Kenya identified poverty as a key factor affecting people's ability to promote own social protection. They also established distinct gender differences of climate change impacts and coping strategies. Many studies have demonstrated that farmers have considerable knowledge on climate variability which informs their coping strategies (Gbetibouo, 2009; Ogalleh, 2012; Moyo et al., 2012; Mulenga and Wineman, 2014). However, Simelton et al. (2011) advices that due to the numerous differences in perceptions of rainfall variability between farmers and scientists, there is need to establish a common understanding in this area. These differences appear in terms of rainfall onset in the past, shifts in rainfall during the rainy season and characterization of cessation (Simelton et al., 2011). Besides decreased precipitation and timing of rainfall, farmers also perceive climate change in terms of increased temperature (Hassan and

Nhemachena 2008; Kemausuor et al., 2011; Nyanga et al., 2011; ATPS 2013).

A study by Gbetibouo (2009) in parts of South Africa reports that farmers perceived changed rainfall patterns in terms of its timing; either coming earlier or later than expected. An equivalent study in Zambia by Mulenga and Wineman (2014) state that both men and women shared similar perceptions of climate parameters. In this case the respondents stated that rainfall seasons had become shorter. Similar findings have been reported by Moyo et al. (2012) in which farmers stated that the rainy season had become more unpredictable starting early and ending abruptly.

Education and age have been shown to influence perceptions and response to climate change (Gbetibouo, 2009; Ndambiri et al., 2013). The capacity to adapt to these climate risks rely on access to resources, information and technology (Thomas, 2008). Reliance on a narrow range of resources and climate sensitive economic activities constitutes individual vulnerability (Adger, 1999). This leads to social and economic stresses within livelihood systems. Thus, documentation of environmental and social interactions at the household level enables differentiation of vulnerable groups based on their assets and entitlements (Eakin and Luers, 2006). These are critical for coping with risks. For instance, Hahn et al. (2009) found out that besides livestock keeping, communities in two districts of Mozambique diversified their income sources by collecting natural resources for sale in the market. Climate change affects the four components of food systems namely food availability, food access, food utilization and food systems stability in several ways (FAO, 2008; Gregory et al., 2005). These include direct effects on crop production, changes in length of growing seasons, changes in market food prices and supply chain infrastructure (Gregory et al., 2005). Various studies on rainfall variability have not only established an inter-annual variability of seasonal rainfall but also variability in seasonal onset and cessation dates (Mugalavai et al., 2008; Recha et al., 2012; Kansiime et al., 2013; Kazembe, 2014).

In some cases this has impacted negatively on food security. It is further argued that changes in radiation, temperature and precipitation will produce changes in crop yields, mixed cropping, cropping systems, scheduling of field operations among other effects (Southworth et al., 2000). Consequently, improvement of food systems contributes to adaptations which are important in coping with climate change. Thus, farmers in risk prone areas, especially the arid and semi-arid environments where rainfall variability impacts strongly on livelihoods, have developed coping strategies to cushion against the uncertainties (Cooper et al., 2008). Growing of different crops has been established as a common adaptation strategy employed by farmers in Kyuso, Kenya (Ndambiri et al., 2013). Bryan et al. (2009) established that although some farmers had a clear perception of changes in rainfall and temperature they did not adjust their farming practices. However other studies have shown that farmer perception and knowledge on climate change influences their farming (Kemausuor et al., 2011). The decision to adapt to this change is highly influenced by the level of accessibility to extension services, credit, climate information as well as land (Kemausuor et al., 2011). Farming experience, government support as well as the wealth status also plays a role in influencing adaptation options for farmers. In particular Kemausuor et al. (2011) establishes that provision of food aid, access to extension services and climate change information was a major driver of decision making among the poorest farmers in parts of Ghana. It has widely been shown that when farmers have considerable knowledge on climate variability this informs their coping and adaptation strategies (Bryan et al., 2009; Ogalleh, 2012; Abid et al., 2015). Diversification of crop varieties, planting of trees, change of planting dates, soil conservation and irrigation are part of strategies used for coping with climate change in parts of Ethiopia and South Africa (Meze-Hausken, 2004; Bryan et al., 2009; Gbetibouo, 2009; ATPS, 2013). Lack of information has been reported as a barrier to taking up adaptation options (ATPS, 2013). Other factors like land size, age, gender and education have also been identified as key factors influencing the propensity to plant trees in Ethiopia (Gebreegziabher et al., 2010) and Ireland (Collier et al., 2002). Accessibility to climate change information influences perception and adaption to climate change (Ndambiri et al., 2013). Notably, radio has been reported as a major source of information on climate change available to farmers (Adesiji et al., 2012). Abid et al. (2015) established that changing crop varieties and planting dates were among the adaptation strategies employed to cope with climate change in Pakistan. In addition, access to information on weather and education level of the household head influenced perception and choice of adaptation measures. It has also been observed that tenancy increases the likelihood of adapting to perceived climate change compared to permanent land ownership. This is occasioned by the desire for more returns from farming investments in tenancy (Rakib et al., 2014; Abid et al., 2015). Adaptation options are sometimes related to changes in on-going farm practices and public policy decision making process with respect to a shift of changing climate (Smit and Skinner, 2002). Adoption of various cropping practices such as mixed cropping, crop diversification, change of planting dates and use of drought tolerant cultivars that mitigate the effects of variable rainfall has also been documented as a means of reducing the risks of crop failure (Challinor et al., 2007; Thomas, 2008; Hassan and Nhemachena, 2008; Adesiji et al., 2012; ATPS, 2013; Ndamani and Watanabe, 2015).

Growing different crops on the same plot or on different

Table 1. Sample size in relation to the study site population.

Ward	Population (2009 Census)	Sample Size (Number of Persons)
Mutithi	26, 864	110
Wamumu	17, 881	74
Gathigiriri	18, 337	74
Tebere	31, 645	127
Total	94, 727	385

plots is seen as another practice of reducing the risk of complete crop failure (Hassan and Nhemachena, 2008). Reducing household food consumption is also employed as a means of adapting to food shortage (Acosta-Michlik and Espaldon, 2008; ATPS, 2013). Ford and Smit (2004) assert that assessment of communities' past responses to climate variability and their future adaptation options gives a means of characterization of their ability to cope with future changes. The extent of farmers' exposure to climate stresses is not well documented in many parts of Kenya. This necessitates generation of information which could be used to inform policy on intervention measures. This study was carried out to establish the extent of farmers' perceptions, exposure and response to climate variability in Mwea region of Central Kenya.

MATERIALS AND METHODS

Study Site

A baseline survey was carried out to establish farmers' perceptions, the extent of exposure and their response to climate variability in Mwea region, Kirinyaga County of Central Kenya. The region consists of two Sub-counties; Mwea East and Mwea West. The total population is estimated at 190, 512 persons while the area covered in the survey has a total population of 94,727 persons based on the 2009 census (IEBC, 2012). It is characterized by bimodal rainfall pattern with the short rains from October to December (OND) and the long rains from March to May (MAM). The major agro-ecological Zones (AEZ) are Lower Midlands 3 (LM3) and Lower midlands 4 (LM4) occupying an area of 132,600 and 332, 700 hectares (ha), respectively (Jaetzold, 2006). The other AEZs are Upper Midlands 3 (UM3) and Upper midlands 4 (UM4) with an area of 2,100 and 37,600 ha, respectively.

Study Design and Sampling

Stratified random sampling technique was used to sample 385 farmers (Cochran, 2007) from two Wards in each Sub County namely Gathigiriri and Tebere in Mwea East and Mutithi and Wamumu in Mwea West. These wards were purposively selected based on their dependence on rain-fed agriculture unlike the rest of Mwea where irrigation is fairly available. Secondly the total number of households interviewed in each ward was determined based on the percentage proportion of ward population in relation to the study site population (Table 1). The households were randomly selected in each ward; if no member was available to respond to the questionnaire the next available household was sampled. A semi-structured questionnaire was used to collect data on household and livelihood characteristics as well as farmers' perceptions and response to climate change. Data collection was achieved through face-to-face individual interviews where the interviewer asked questions then immediately recorded the response in the questionnaire.

Data Analysis

Farmers' perceptions were assessed by frequency and percentage distribution using the Statistical Package for Social Sciences (SPSS). The differences between the distributions of responses were determined through the Pearson's Chi-square test at 5% level of significance.

RESULTS AND DISCUSSION

Respondents Gender, Age And Level Of Education

There were significantly ($p=0.0004$) more male (59.1%) than female (40.9%) respondents in this study. Highly significant ($p<0.001$) age differences were also observed where 37.4% were 46 years and above, 34% between 36 to 45 years, 28.3% between18 to 35 years and only 0.3% were below 18 years of age. This observation suggests that farming remains unattractive to the youth. The differences in the level of education among the respondents was highly significant ($p<0.001$). 13.5% of the respondents had attained tertiary education, 41.5% had attained secondary education and 45% had attained primary education.

Land Ownership In Relation To Gender And Age Of Respondents

Leasing of land was reported by 66.8% ($p<0.001$) of the

Table 2. Relationship between gender and respondents' characteristics in Mwea, Kenya.

	Variable	Percentage Respondents	
		Male	Female
1.	Ownership of separate piece of land		
a)	No other piece of land owned	22.7	24.1
b)	Own another piece of land	32.4	16.3
2.	Response to change in rainfall patterns		
a)	Have not changed their farming practices	25	4.6
b)	Have changed their farming practices	37.7	32.7

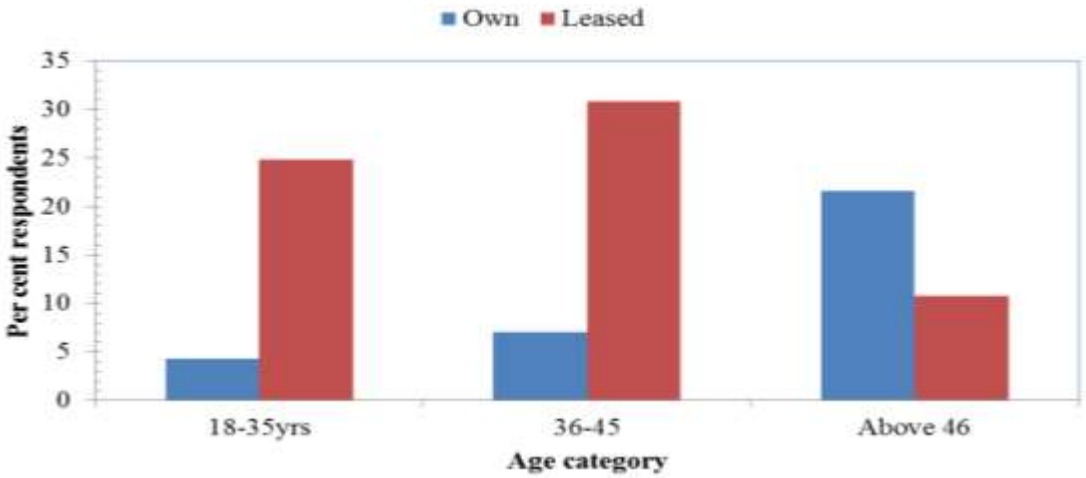

Figure 1. Relationship between respondents with separate pieces of land either owned or leased and their age in Mwea, Kenya.

respondents. There was a significant relationship (p=0.007) between gender and ownership of a separate piece of land other than the place of residence. Thus, there were more males (32.4%) than females (16.3%) reporting ownership of separate pieces of land (Table 2). It was evident that leasing land (p<0.001) was mainly by those between 36 to 45 years (30.8%) (Figure 1). The tendency to lease land indicates a desire by farmers in this region to expand their food sources. This could be due to the inadequacy to meet their food requirements from their own farms. Studies by Rakib et al. (2014) and Abid et al. (2015) have demonstrated that tenancy increases the likelihood of adapting to climate change unlike permanent land ownership based on the desire for higher returns by tenants. Generally most of the people in this region owned 2 to 5 acres of land.

Fuel Availability and Copping Strategies

Wood was the most common type of fuel used as narrated by 46.1% of the respondents. Generally planting trees has been reported as a means of copping with climate change (Meze-Hausken, 2004; Bryan et al., 2009; Gbetibouo, 2009) among other practices. This survey reveals that younger farmers have not grasped the importance of trees in combating climate change. Results show a relationship (p<0.001) between respondents with trees on their farms and their age category (Figure 2). Thus majority (30.1%) of those with trees on their farms were 46 years and above. This echoes other studies that have identified age of farmer as one of the determinants on planting trees in Ethiopia (Gebreegziabher et al., 2010) and Ireland (Collier et al., 2002). Notably, although 67.3% of the respondents (p<0.001) were aware of energy saving devices, only 29.2% had tried using them. In this case, 97.6% had tried the energy saving stove. The other reported devices were solar cooker (1.2%) and fireless cooker (1.2%). This scenario reveals some level of exposure to climate related risks and disasters.

Water Availability And Copping Strategies

It was established that most of the households (66.4%) drew water from nearby streams/rivers (Figure 3). These

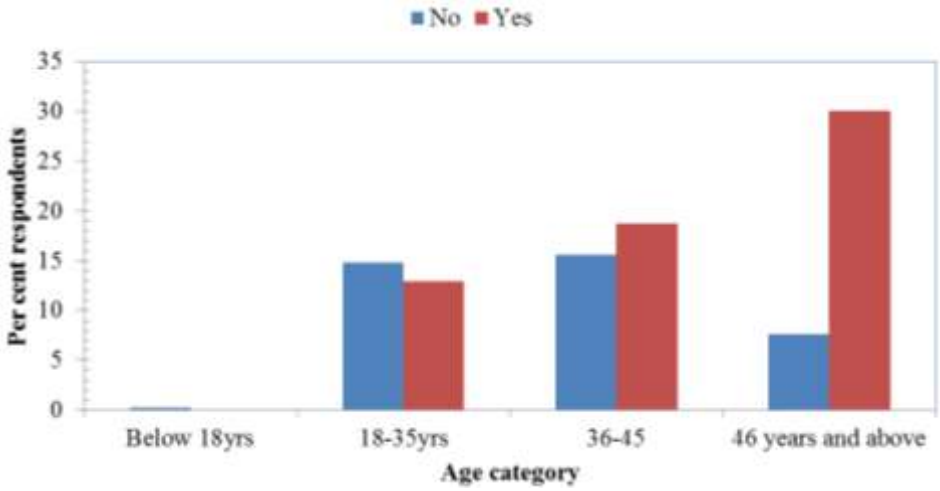

Figure 2. Proportion of farmers with trees on their farm in relation to their age in Mwea.

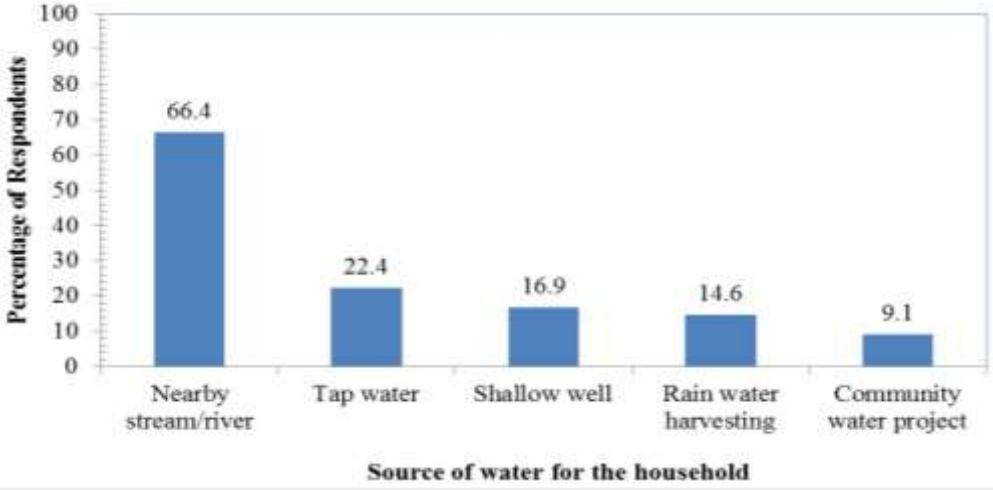

Figure 3. Water sources in Mwea region as reported by respondents.

water sources are climate dependent since their flow depends on rainfall received during a particular period. This further increases the level of household vulnerability to climate change and variability in this region as stated by Adger (1999). Water sources were within reach since it took less than one hour to get to the source ($p<0.001$). Borrowing water from neighbours in times of shortage was common as reported by 69.6% of the respondents. Other coping strategies were buying water from water vendors (21.7%) or water kiosks (8.7%).

Perceptions Towards Climate Variability And Response

Results show that 75.3% of the respondents were aware of climate change ($p<0.001$). The findings confirm that education level influences climate change perception and response ($p=0.003$) (Figure 4). Studies by Ndambiri et al. (2013) and Gbetibouo (2009) report similar findings in Kenya and South Africa, respectively. Radio was the main source information on climate change (Figure 5) in this region ($p<0.001$) which agrees with another study by Adesiji et al. (2012) in Nigeria. Also, 95.6% of the respondents indicated that rainfall patterns had changed ($p<0.001$) over the last 20 years. Change in rainfall patterns and temperature was reported by all respondents regardless of the age or level of education ($p<0.001$) (Table 3). Rainfall variability was described as being more unpredictable (55.7%), decreased in days and amount (41.8%) while only 2.4% were of the opinion that it had increased. This coincides with other findings by Moyo et al. (2012) in which farmers stated that the rainy season had become more unpredictable starting early and ending abruptly. This study established that 98.3% ($p<0.001$) of all respondents agreed that temperatures had changed over the last 20 years.

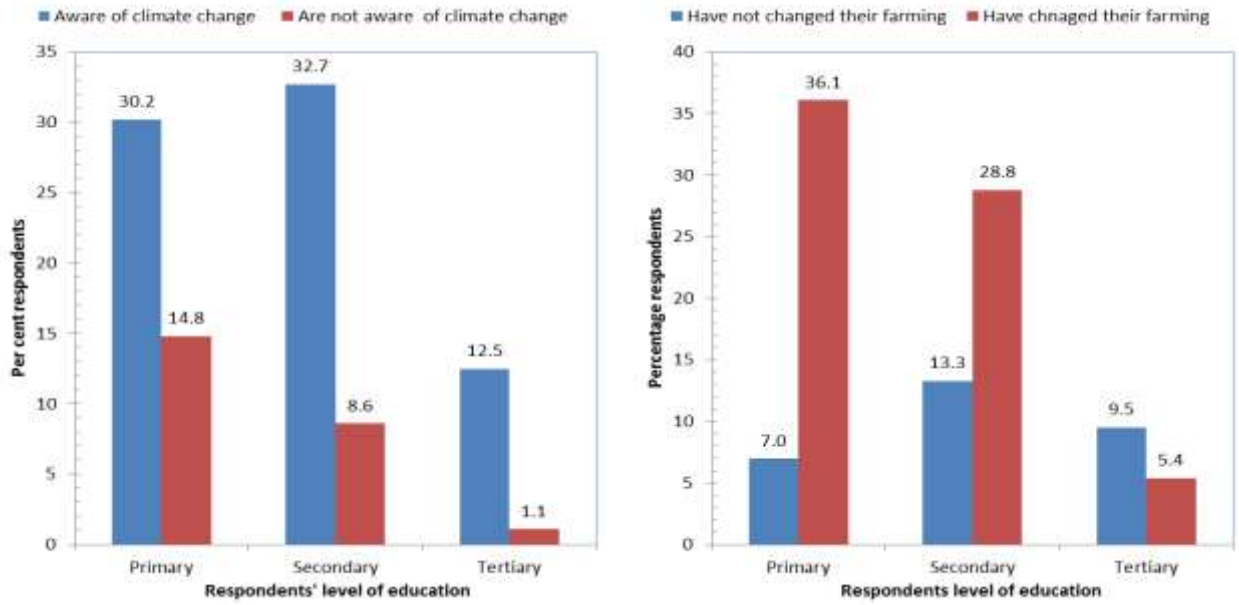

Figure 4. Relationship between level of education and climate change awareness and response in Mwea, Kenya.

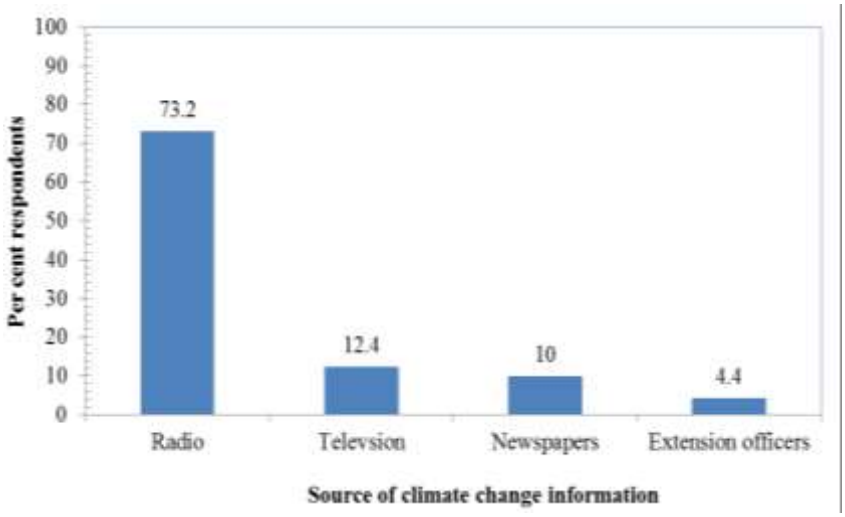

Figure 5. Main sources of climate change information in Mwea, Kenya.

Table 3. Respondents' perceptions and response to climate change in Mwea, Kenya.

Variable	Respondents characteristics		
	Age	Level of education	Gender
Climate change awareness	ns	*	ns
Perception to change in rainfall patterns	**	ns	ns
Influence of change in rainfall pattern to farming	ns	**	**
Perception to change in temperatures	**	ns	ns

** Highly significant: p<0.001; *significant: p=0.003; ns: not significant.

Temperatures had become hotter as narrated by 75.7% of the respondents; 21.9% said temperatures had become more unpredictable and 2.3% thought it was cooler.

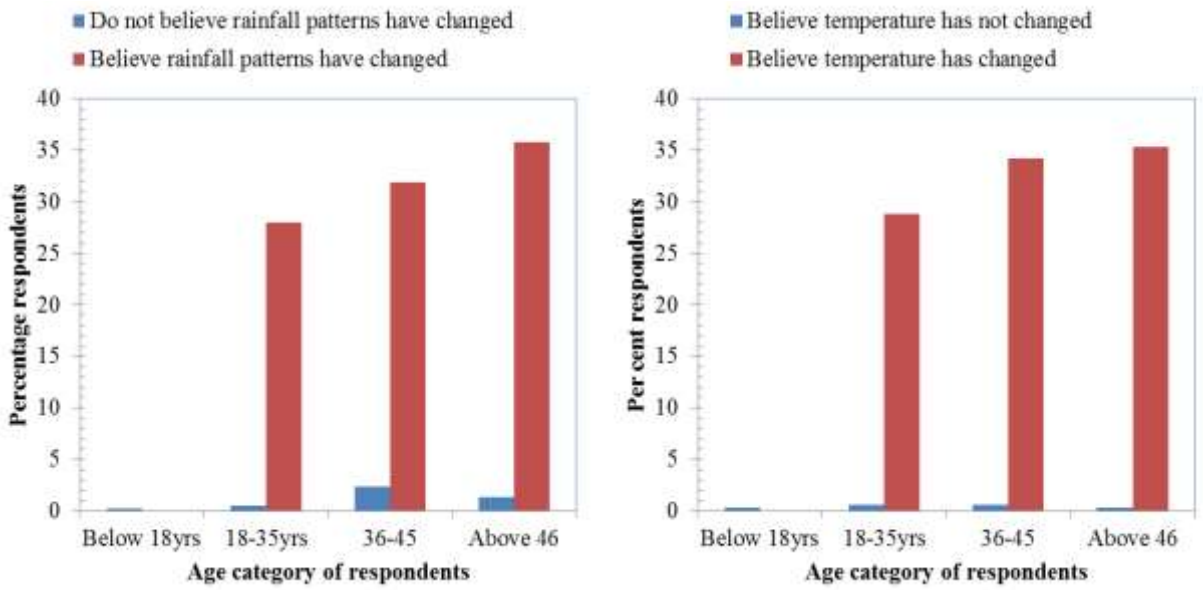

Figure 6. Perceptions to change in temperature and rainfall in relation to respondents' age category.

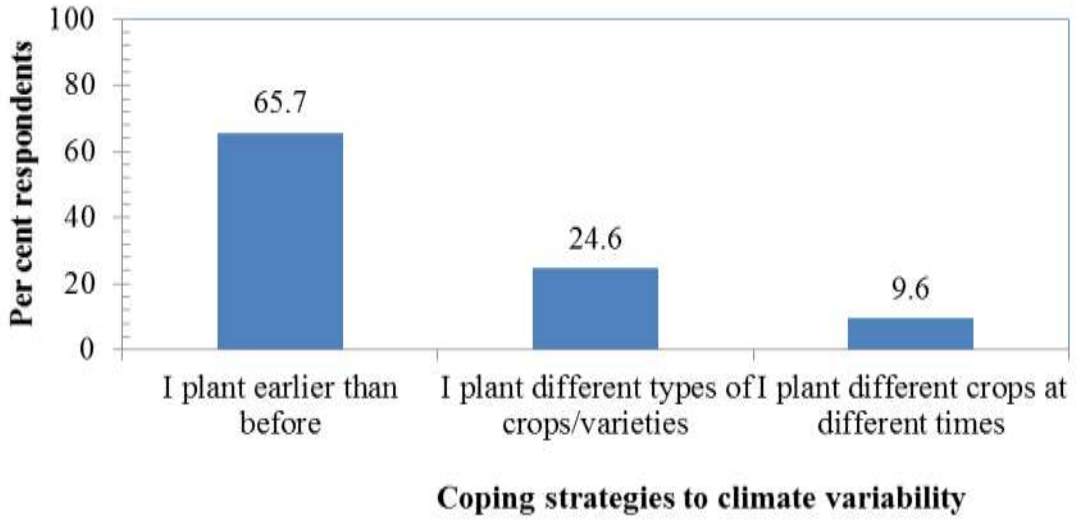

Figure 7. Coping strategies to climate change in Mwea, Kenya.

The observation on temperature change was significant (p<0,001) as reported by most respondents irrespective of their age (Figure 6). This similarity in gender perceptions and response on climate variability has previously been reported by Mulenga and Wineman (2014) in Zambia. Similarly, many scholars have established that besides decreased precipitation and timing of rainfall, farmers also perceive climate change in terms of increased temperature (Hassan and Nhemachena, 2008; Gbetibouo, 2009; Kemausuor et al., 2011; Nyanga et al., 2011; ATPS 2013). There was no significant (p>0.05) difference between the reported seasonal variation in rainfall patterns. Although majority of the respondents (38.4%), irrespective of gender, were not sure of the season that had changed the most; 70.4% (p<0.001) of them affirmed that the change in rainfall patterns had influenced their farming system (Figure 7). This agrees with findings by Kemausuor et al. (2011) who reports that perception and knowledge on climate change influenced farming systems in Ghana. Other studies have also shown that not all farmers respond to perceived changes in rainfall and temperature (Bryan et al., 2009). These findings also concur with those of other scholars who report that climate change awareness influences choice of adaptation strategies (Gbetibouo, 2009; Ogalleh, 2012; Moyo et al., 2012; Mulenga and Wineman, 2014). Early planting was a common copping strategy to rainfall variability as reported by 65.7%

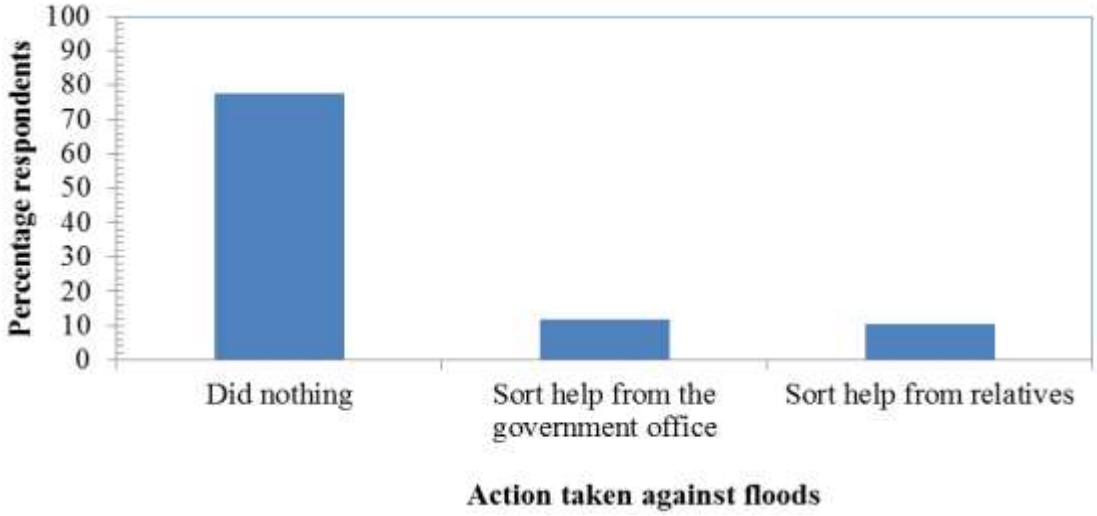

Figure 8. Response to effects of flooding in Mwea, Kenya.

(p<0.001) of the respondents. The other copping strategies were planting different crops at the same time (24.6%) and planting different crops at different times (9.6%). These results concur with similar findings by other workers (Challinor et al., 2007; Thomas, 2008; Hassan and Nhemachena 2008; Adesiji et al., 2012; ATPS, 2013; Ndamani and Watanabe, 2015). Likewise Thomas (2008) has stated that access to resources, information and technology affects the capacity to adapt to climate risks. Table 3 summarizes the perceptions on climate variability and its influence on farming in relation to age, gender and level of education.

The Extent Of Floods And Drought Stresses In Mwea, Kenya

Although there was no significant difference between those who had experienced floods in the last 20 years and those who had not; it was established that 90% (p<0.001) of those who had experienced floods also suffered some damage as a result. In addition, 77.5% of those who suffered damages from flooding did not take any remedial measures (Figure 8). There was no prior warning on the occurrence of floods as recounted by 70.2% of the respondents. A significant (p<0.001) number (69.4%) of the respondents had experienced drought in the last 20 years out of whom 97.6% suffered consequent damages. Experience of drought was reported by both male (34.1%) and female (35.5%) respondents. The damages included lost crops (p<0.001) stated by 74.6% of the respondents; 16.8% experienced water shortage and 8.6% lost their livestock. It was noted that 61.3% of the victims of drought did not have prior information before the drought occurred. This exposure to environmental risks raises the level of vulnerability to climate change in this region. This agrees with other studies (Ford and Smith, 2004; Schröter et al., 2005; Eakin and Luers, 2006; Brouwer et al., 2007; Heltberg et al., 2009) which report on the relationship between exposure to environmental risks and vulnerability. The capacity to adapt to these climate risks relies on access to resources, information and technology (Thomas, 2008).

The Status Of Food Security And Response To Shortage In Mwea, Kenya

It was established that most households (89.9%) got their food from family land (p<0.001) while the rest bought food from the market. However, results also indicated that 32.7% (p<0.001) of the households did not have adequate food throughout the year. This food shortage can be attributed to climate variability and its effects on the components of food security as described by Gregory et al. (2005). These workers state that climate change has direct effects on crop production, changes in length of growing seasons, changes in market food prices and supply chain infrastructure. Some of the strategies used to cope with food shortage included reducing number of meals per day (42.2%), asking for help from relatives (27.8%), getting relief food from government (20%) and getting relief food from other organizations (10%) (Figure 9). Acosta-Michlik and Espaldon (2008) also reported that reducing household food consumption was employed as a means of adapting to food shortage in Philippines.

CONCLUSION

This study reveals that a considerable level of climate change awareness exists among farmers in Mwea region. Farmers in this area are highly exposed to climate

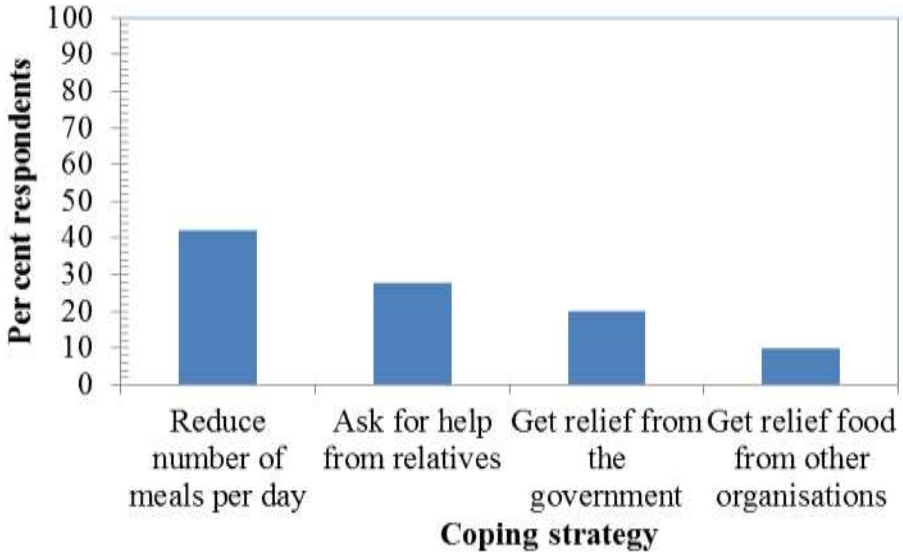

Figure 9. Coping strategies to food shortage in Mwea, Kenya.

risks based on their dependence on rain-fed agriculture as the main source of food. Besides that, streams are the main source of water. Wood fuel is commonly used despite farmers having few trees on their farms. They are also exposed to the risk of drought occurrence. This exposure to environmental risks and the reliance on climate dependent resources raises the level of vulnerability to climate change and variability in this region. However farmers in this region have shown significant level of response to climate variability through adjustment of their farming practices, diversification of income sources and change of food habits. Radio is a powerful media that can effectively be used to relay information on climate change, adaptation strategies and early warning to farmers. There is need to document, improve and upscale the adaptation strategies currently being employed by farmers in Mwea. Policy and technological interventions on mitigation of climate change and variability are also needed in this region. These can form objectives for future studies.

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REFERENCES

Abid M, Scheffran J, Schneider UA, Ashfaq M (2015). Farmers' perceptions of and adaptation strategies to climate change and their determinants: the case of Punjab province, Pakistan. Earth System Dynamics, 6(1): 225-243.

Acosta-Michlik L, Espaldon V (2008). Assessing vulnerability of selected farming communities in the Philippines based on a behavioural model of agent's adaptation to global environmental change. Global Environ. Change, 18(4): 554-563.

Adesiji GB, Matanmi BM, Onikoyi MP, Saka MA (2012). Farmers' perception of climate change in Kwara State, Nigeria. World Rural Observations 4(2): 46-54.

Adger WN (1999). Social vulnerability to climate change and extremes in coastal Vietnam. World Develop., 27(2): 249-269.

African Technology Policy Studies Network, ATPS (2013). Farmers' Perception and Adaptive Capacity to Climate Change and Variability in the Upper Catchment of Blue Nile, Ethiopia Bewket Amdu, Azemeraw Ayehu, Andent Deressa, ATPS WORKING PAPER No. 77.

Brouwer R, Akter S, Brander L, Haque E (2007). Socioeconomic vulnerability and adaptation to environmental risk: a case study of climate change and flooding in Bangladesh. Risk Analysis, 27(2): 313-326.

Bryan E, Deressa TT, Gbetibouo GA, Ringler C (2009). Adaptation to climate change in Ethiopia and South Africa: options and constraints. Environ. Sci. Policy, 12(4): 413-426.

Challinor A, Wheeler T, Garforth C, Craufurd P, Kassam A (2007). Assessing the vulnerability of food crop systems in Africa to climate change. Climatic Change, 83 (3): 381-399.

Cochran WG (2007). Sampling techniques. John Wiley & Sons.

Collier P, Dorgan J, Bell P (2002). Factors Influencing Farmer Participation in Forestry. COFORD, Dublin, Ireland. National Council for Forest Research and Development.

Cooper PJM, Dimes J, Rao KPC, Shapiro B, Shiferaw B, Twomlow S (2008). Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change. Agriculture, Ecosyst. Environ. 126 (1): 24-35.

Eakin H, Luers, AL (2006). Assessing the vulnerability of social-environmental systems. Ann. Rev. Environ. Resour., 31(1): 365.

FAO (2008). Food Security: A Framework Document. FAO, Rome.

Ford JD, Smit B (2004). A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change. Arctic, 57 (4): 389-400.

Gbetibouo GA (2009). Understanding farmers' perceptions and adaptations to climate change and variability: The case of the

Limpopo Basin, South Africa (Vol. 849). International Food Policy Research Institute, IFPRI Research Brief.
Gebreegziabher Z, Mekonnen A, Kassie M, Köhlin G (2010). Household Tree Planting in Tigrai, Northern Ethiopia: Tree Species, Purposes, and Determinants Working Papers in Economics No 432 School of Business, Economics and Law at University of Gothenburg.
Gregory PJ, Ingram JS, Brklacich M (2005). Climate change and food security. Philosophical Transactions of the Royal Society of London B: Biol. Sci., 360 (1463): 2139-2148.
Hahn MB, Riederer AM, Foster SO (2009). The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change-A case study in Mozambique. Global Environ. Change, 19(1): 74-88.
Hassan R, Nhemachena C (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. Afr. J. Agric. Resour. Econ., 2(1): 83-104.
Heltberg R, Siegel PB, Jorgensen SL (2009). Addressing human vulnerability to climate change: toward a 'no-regrets' approach. Global Environ. Change 19(1): 89-99.
Independent Electoral and Boundaries Commission, IEBC (2012). http://www.infotrackea.co.ke/services/leadership/constituencyinfo.php?cinf=wards&t=100(Accessed on 7th August 2014).
Jaetzold R, Schmidt H, Hornetz B, Shisanya C (2006). Farm Management Handbook of Kenya. Natural Conditions and Farm Management Information Vol. II 2nd Edition, Part B, Central Kenya.
Kansiime MK, Wambugu SK, Shisanya CA (2013). Perceived and actual rainfall trends and variability in Eastern Uganda: Implications for community preparedness and response. J.Nat. Sci. Res., 3(8): 179-194.
Kazembe A (2014). Determining the onset and cessation of seasonal rains in Malawi. Post Graduate Diploma Research Project. Department of Meteorology, University of Nairobi,Kenya.
Kemausuor F, Dwamena E, Bart-Plange A, Kyei-Baffour N (2011). Farmers' perception of climate change in the Ejura-Sekyedumase district of Ghana. ARPN J. Agric. Biol. Sci., 6(19): 26-37.
Meze-Hausken E (2004). Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia. Climate Res., 27: 19-3.
Moyo M, Mvumi BM, Kunzekweguta M, Mazvimavi K, Craufurd P, Dorward P (2012). Farmer perceptions on climate change and variability in semi-arid Zimbabwe in relation to climatology evidence. Afr. Crop Sci. J., 20 (2): 317-335.
Mugalavai EM, Kipkorir EC, Raes D, Rao M S (2008). Analysis of rainfall onset, cessation and length of growing season for western Kenya. Agric. Forest Meteorol., 148(6): 1123-1135.
Mulenga BP, Wineman, A (2014). Climate Trends and Farmers' Perceptions of Climate Change in Zambia (No. 186605). Michigan State University, Department of Agricultural, Food, and Resource Economics.
Ndamani F, Watanabe T (2015). Farmers' Perceptions about Adaptation Practices to Climate Change and Barriers to Adaptation: A Micro-Level Study in Ghana. Water, *7*(9): 4593-4604.
Ndambiri HK, Ritho CN, Mbogoh SG (2013). An evaluation of farmers' perceptions of and adaptation to the effects of climate change in Kenya. Int. J. Food Agric. Econ., 1(1): 75-96.
Nyanga PH, Johnsen FH, Aune JB, Kalinda TH, (2011): Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. J. Sustain. Develop., 4 (4): 73-85.
Ogalleh SA, Vogl CR, Eitzinger J, Hauser M (2012). Local perceptions and responses to climate change and variability: the case of Laikipia district, Kenya. Sustainability, 4(12): 3302-3325.
Ongoro EB, Ogara W (2012). Impact of climate change and gender roles in community adaptation: A case study of pastoralists in Samburu East District, Kenya. Int. J. Biodiver. Conserv., 4(2): 78-89.
Rakib MA, Rahman MA., Akter MS, Bhuiyan MA (2014). Climate change: Farmers perception and agricultural activities. Herald. J. Geogr. Reg. Plan, 3: 115-123.
Recha CW, Makokha GL, Traore PS, Shisanya C, Lodoun T, Sako A (2012). Determination of seasonal rainfall variability, onset and cessation in semi-arid Tharaka district, Kenya. Theoretical Appl. Climatol., 108 (3-4): 479-494.
Schröter D, Polsky C, Patt AG (2005). Assessing vulnerabilities to the effects of global change: an eight step approach. Mitigation and Adaptation Strategies for Global Change, 10(4): 573-595.
Simelton E, Quinn CH, Antwi-Agyei P, Batisani N, Dougill AJ, Dyer J, Stringer LC (2011). African farmers' perceptions of erratic rainfall. Sustainability Research Institute Paper, 27.
Smit B, Skinner MW (2002). Adaptation options in agriculture to climate change: a typology. Mitigation and Adaptation Strategies for global Change, 7(1): 85-114.
Southworth J, Randolph JC, Habeck M, Doering OC, Pfeifer, RA, Rao DG, Johnston JJ (2000). Consequences of future climate change and changing climate variability on maize yields in the midwestern United States. Agric. Ecosyst. Environ., 82(1): 139-158.
Thomas RJ (2008). Opportunities to reduce the vulnerability of dryland farmers in Central and West Asia and North Africa to climate change. Agric. Ecosyst. Environ., 126(1): 36-45.