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Factors Influencing Banana Farmers Adaptation Strategies to Climate Variability in Meru County Kenya

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ABSTRACT

Food production among rural farmers globally has been threatened by climate variability impacts leading to food scarcity. Small holder farmers face challenges in the choice of appropriate adaptive mechanisms when responding to the impacts associated with climate variability. Several case studies have focused on adaptive strategies related to crop production with limited attention on the socioeconomic factors influencing adaptation strategies towards climate variability with reference to specific crops. Thus, a study was carried out in Meru County, Kenya to evaluate the socio-economic factors that influence banana farmer's adaptation strategies to climate variability. The study site was in Imenti south sub-county which was purposively selected due to its long-term history of banana farming. Field survey techniques were used in the data collection where 251 banana farmers were sampled and data collected using open ended questionnaires and Focus Group Discussions. Logit regression model was used to determine the socioeconomic factors influencing farmers' choice of the adaptation strategy to climate variability. The study realized that irrigation and shifting planting dates were the most preferred adaptation strategies among small holder's banana farmers at 84.9% and 4.8% respectively. Land acreage under banana production, age of the household head, access to extension services, access to financial facilities, agro ecological zone setting and perception to climate variability were significant in explaining the farmers' adaptation to irrigation as a strategy. Further, provision of climate information to farmers will enhance promotion of crop diversification, adoption of drought tolerant banana varieties and shifting of planting dates thus enhancing resilience to farming systems.

Keywords: Adaptation, Banana, Climate Variability, Socioeconomic and Strategy.

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1. Introduction

Agriculture production in developing countries is most vulnerable to the negative effects of climate-induced events because of their low level of adaptation and poverty (IFAD, 2010). Increases in the frequency of droughts and floods due to climate variability are projected to affect local agricultural production negatively and specifically the subsistence sector who are the small holder farmers (Wik et al). Further it has been reported that food production is particularly sensitive to climate variability due to the fact that crop yields depend largely on climate variables such as temperature levels and rainfall patterns and amounts (Wik et al). In addition, (IPCC, 2014), notes that climate related impacts will increase risks of food insecurity and breakdown of the food systems.

Banana (Musa spp.) is the most cultivated crop in the rural areas as a source of income and food for the family. Banana is ranked 4th as the world's most valuable fruit and staple food crop in developing world, after rice, wheat and maize and originated from Asia (Frison et al., 2004; FAO, 2004; Ramirez et al, 2011). Small scale production is the most common means of growing bananas and plantains in the tropical world and are responsible for over 87% of global banana/plantain production (INIBAP, 1996). Banana are perennial, low-input with small farm size (0.25-5 ha) and rural-based systems in Africa, Asia and Central America. The continuous availability of harvestable bunches from a banana stool contributes to the year-round food and income security of banana growers especially the rural smallholders. Banana is the most cultivated crop in the rural areas of Kenya and acts as a source of income and food for the households (GOK, 2012). Optimal banana production faces a myriad of challenges including high prevalence of pests and disease, poor seed and disorganized marketing systems. This has been exacerbated by climate variability in many scenarios.

According to (GOK, 2012), the leading counties in banana production in Kenya are Meru (40%), Kirinyaga (21%), Tharaka Nithi (19%). In Meru county banana is the key source of livelihood for Meru's population and is grown on 2.2% of the County's total agricultural land. In 2015, a total of 382,390 metric tonnes (MT) were produced earning the farmers approximately Kshs 3,700 million. Banana grows in a range of environments and produce fruit throughout the year, thus can sustainably provide source of food during the 'hungry period' between the harvests of other crops. Banana is particularly suited to intercropping systems and to mixed farming with livestock. Due to their suitability for production in backyard systems, bananas are also an important component of peri urban agriculture.

2. Literature review

Climate variability has been reported as a key driver to low production among rural subsistence communities (Kamau et al., 2011). It is hypothesized that climate variability has profound effect on the sustainable food value chain component of agricultural production and also delivery of the final produce to consumers. These include impacts on production, harvesting, storage, transportation and trading of farm produce. Impacts of climate variability are likely to sophisticate the uncertainty and volatility of food production, especially in the Sub-Saharan countries (ILRI, 2007). This calls for sustainable adaptation strategies in order to minimize farmers' vulnerability to the impacts of climate variability.

Adaptation to climate variability refers to adjustments or variability in the system to minimize the negative impact and optimize the positive impacts of climate variability. It has been recognized that sustainable adaptation measures can reduce negative impacts of climate variability on agricultural production (Kabubo-Mariara, and Karanja, 2007). Adaptation could be at different levels of government, for example, regional, national, sub-national and local levels. Adaptation at local level is the most critical issue as local actors are the ones that face the severity of climate variability (UNFCCC, 2009). Agricultural production in Kenya is heavily reliant on rain and there is need to put in place a robust sustainable adaptation mechanism which will address the climate variability-related vulnerabilities and risks which have already been experienced and those expected in future by small holder farmers.

Adaptation strategies to climate variability can be grouped into autonomous or independent and planned or public sector adaptation strategies. Private adaptation strategies involve action taken by non-state agencies such as farmers, communities or organizations and or firms in response to impacts of climate variability. According to Bruin (2011), the sustainable adaptation strategies include switching crops, shifting planting calendar/dates, engaging new management practices for a specific climate regime, changing irrigation system and selecting different cropping technologies. Public adaptation involves actions taken by local, regional and or national government to provide infrastructure and institutions to reduce the negative impact of climate variability. Public adaptation strategies include development of new irrigation infrastructure, transport or storage infrastructure, land use arrangements and property rights and water shed management institutions (World Bank, 2010).

Smallholder farmers can sustainably adapt to climate variability by changing planting dates and diversifying crops (Gbetibouo, 2009). This can be possible if government provides them with the necessary support in the value chain. Smallholder farmers can also adapt to climate variability by practicing soil and water conservation measures and planting trees (Yesuf et al, 2008). Scholarly studies conducted in Sri Lanka, pointed out that adverse impact of climate variability on agricultural production could be minimized by applying sustainable adaptation strategies such as introduction of micro irrigation, changing planting dates, and crop diversification (Esham and Garforth, 2013). Adaptation reduces the level of damages that might have otherwise occurred. In addition, many social, economic, technological and environmental trends also critically shape the ability of farmers to perceive and adapt to impacts of climate variability.

Experience has shown that, identified adaptation measures do not necessarily translate into changes, because adaptation strategies to climate variability and physiological barriers to adaptation are locally defined (IPCC, 2007). A better understanding of the local dimensions of climate variability impacts are essential when developing appropriate and sustainable adaptation strategies that will mitigate adverse consequences of climatic variability. The knowledge of the adaptation choices and factors affecting the adaptation methods to climate variability enhance policy towards tackling the sustainability challenges that climate variability is imposing on households having little adaptation skills and capacities. Food productivity can be improved with proper adaptations at household level (Di Falco and Veronesi, 2013; Di Falco, 2014).

Adaptations strategies have been delivered from the Sustainable Development Goals (SDGs) no 2 and 13 of the united Nation which addresses zero hunger and climate action respectively. Concerning the two SDGs, the key areas are on food productivity and resilience strategies to climate variability. The main features of adaptation are anchored through three pillars which are reliable, affordable and acceptable practices. Adaptation to climate variability requires that households appreciate that there exist climate variations and recognize useful adaptation options, choosing among a wide range of adaptation strategies at their disposal. Hence, households within the same geographical location use difference adaptation strategies in response to climate variability due to their capability (Micah and Absalom, 2014).

Knowledge on the adaptation methods and factors affecting farmers' choices enhances efforts directed towards tackling the challenges that climate variability is imposing on small holders' farmers (Deressa et al., 2009). Agricultural practices such as use of improved crop varieties, planting trees, soil conservation, changing planting dates and irrigation are the most widely used sustainable adaptation strategies whereas several socio-economic, environmental and institutional factors and the economic structure are key drivers influencing farmers to choose specific adaptation strategy (Bryan et al., 2013).

Farmers in Kenya are believed to be among those adversely affected by climate variability. While adaptation to impacts of climate variability seem to be the most appropriate and responsive way for small holders' subsistence farmers to lessen the negative impacts of climate, farmers are assumed to have inadequate knowledge and resources regarding response mechanisms. Thus, this study was aimed at assessing factors determining farmers' adaptive strategies to climate variability with specific reference to banana farmers in Meru county, Kenya.

3. Methods and materials

3.1 Description of the study area

The study was carried out in Meru County within Mt Kenya region. According to UTM projection, Meru County falls within zone 37 North and approximately between longitudes 370 0' 00" East and 380 30' 00" East and latitude 00 20' 00" North and 00 40' 0" South. The region receives bimodal rainfall pattern with the long rains occurring from March to May (MAM) while the short rains come in October to December (OND), but occasionally this pattern is disrupted by abrupt and adverse changes in climatic conditions. According to Jaetzoid et al., (2006), the climate of Meru County can be described as cool and warm. Temperatures in the highlands range between 140C to 170C while those of the lowlands, range between 220C to 270C. The region receives an average rainfall of between 1250mm annually (GOK, 2015).

3.2 Research design and sampling methods

The study adopted mixed research design to determine adaptation strategies and factors influencing adaptation strategies in Meru County within the Mt. Kenya region. The study involved use of triangulation of methods whereby both qualitative and quantitative techniques were adopted to collect data using structured questionnaire administered to small holder farmers. The study area was purposively selected to include diverse locations where banana has been grown for the target period from 1980-2017. Thus, six sites were selected in Imenti South sub-county (Mitunguu, Igoji East, Igoji West, Abogeta West, Abogeta East and Nkuene). Simple random sampling method was used to select the participating respondents for the study. In this study, the target population consisted of smallholder's banana farmers. According to GOK, (2009), the population of Imenti-South sub county was approximately 179,604 with 47,197 households. Thus, a sample size of 251 respondents was sufficient for this study.

Data was collected using individual interviews, Focus Group Discussions (FGDs), data mining from records and researcher observation. Both quantitative and qualitative methods of data collection and acquisition were used. Quantitative methods included the use of surveys to collect data on adaptation strategies. Close ended questionnaires were used to capture key factors determining farmers' adaptations strategies. Qualitative methods of data collection such as interviews to key informants, (FGDs), photographs and observations were used to enrich the primary data. Key issues on the impacts of climate variability and adaptations on banana value chain were captured using in-depth interviews from key informants. FGDs sessions were undertaken to validate data collected from individual households. In-depth interviews were administered to key informants who included agricultural extension officers and Horticulture Crop Directorate (HCD) officers.

3.3 Data analyses

Survey data from questionnaires were coded and entered in SPPS Version 21 (SPSS, 2012) for analysis. Farmers' adaptation strategies were analyzed using binary models. A binary choice model was used to estimate the factors influencing farmers' adaptation strategies. Binary probit or logit model was employed where the number of choices available were two (whether adapter or non-adapter). The dependent variables in this study was adaptation strategy.

Thus,

For Farmers households' characteristics influencing adaptation strategies of climate variability

$R^*i = Xi\alpha + \varepsilon i$

Where

R^* is the latent variable,

ε is the error term, and

X denotes the set of explanatory variables or factors that influence households' choice on adaptation strategy.

Five adaptation strategies were identified which farmers choose from. These strategies were; drought tolerant varieties; shifting planting dates; no adaptation (where farmers did not take up any adaptation strategy); crop diversification; and irrigation. The farmers were assumed to adopt only one strategy for instance (adaptation strategies = 1, while not adapting =0). Multinomial logistic regression model (MNL) was used to analyse the factors influencing the farmers choice of climate variability adaptation strategies by households while descriptive statistics was used to analyse adaptation strategies used by households. According to Magombo et al. (2011), MNL model for choice of adaptation strategies specifies the relationship between the probability of choosing an adaptation option and the set of explanatory variables. The MNL model was as follows;

$Yi = \beta 0 + \beta 1 X1 + \beta 2 X2 + \beta 3 X3 + \beta 4 X4 + \ldots\ldots\ldots\ldots \beta n Xn + ei$

Where Yi = adaptation strategy (drought tolerant varieties; shifting planting dates; irrigation; crop diversification).

Xi, where i = 1, 2, 3, 4,……..n, are explanatory variables.

β0: is the intercept,

β1…… βn.: are slopes of the equation in the model.

The dependent variable was regressed on a set of explanatory variables. Prior to the estimation of the logistic regression model the explanatory variable were checked for the existence of multicollinearity.

4. Results and discussions

In response to long-term perceived changes in climate in Meru region, the farmer-respondents in the study area have undertaken a number of adaptation measures which included adoption of drought resistant banana varieties, crop diversification, shifting planting dates and use of irrigation as shown in Figure 1.

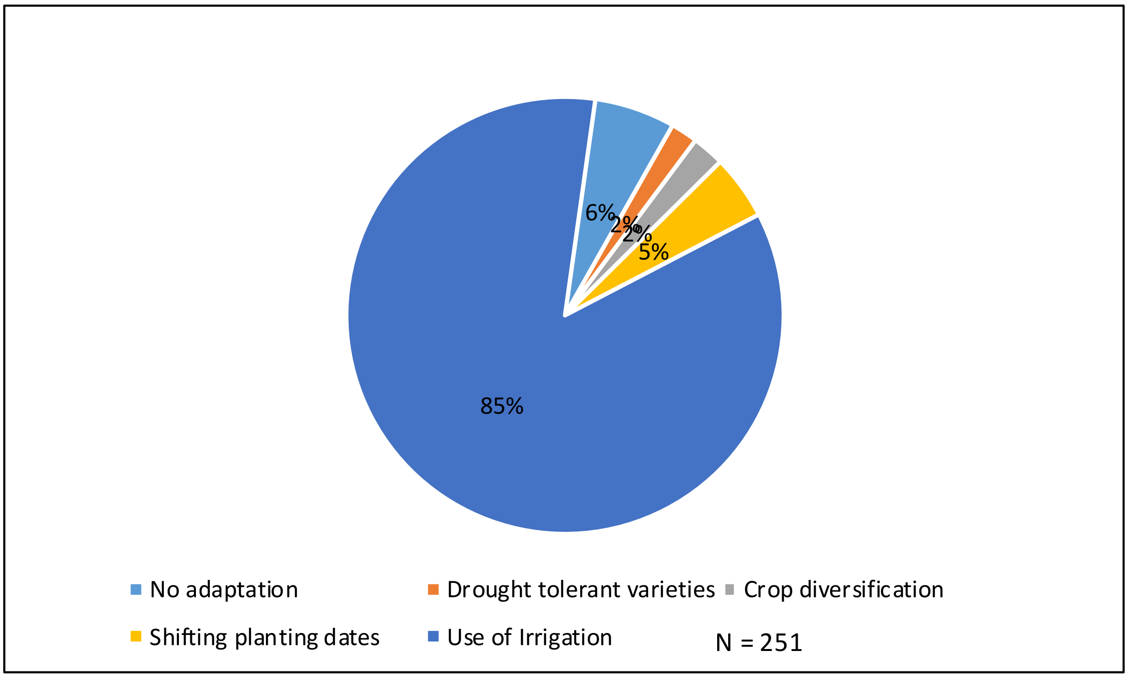

Figure 1. Adaptation strategies among the respondents in the study region

Majority of the respondents in the study area opted irrigation (84.9%) as an adaptation strategy while other preferred shifting planting dates (6%), and crop diversification (2.4%). Some farmers did not adapt to strategy to climate variability (5. 9%). Thus, irrigation was the sure way to caution farmers against the negative impacts of climate variability. According to Yesuf et al., (2008), farmers' adaptations to climate variability strategies is influenced by frequent and more accurate weather information from meteorological departments, formal and informal institutions, access to credit and extension information, amount of seasonal rainfall, geographical location, household size, age and literacy of household head. Further, Nhemachena and Hassan (2008), found that markets, access to electricity and technology, land ownership rights and gender of the household head significantly influence household choice when choosing adaptation strategies to climate variability while Gbetibouo (2009) cited poverty, lack of secure property rights, lack of savings, farm size, lack of technical skills and off-farm employment as additional barriers to adoption of climate variability adaptation strategies. Deressa et al., (2009), concluded that farmers 'level of education, access to extension services, access to credits, climate information, social capital and agro-ecological settings have great influence in farmers' choice of adaptation methods to climate variability while financial constraints and lack of information about adaptation methods hinders the farmers' to accept other adaptation strategies.

4.1 Socio-economic factors influencing farmers' adaptation strategies to climate variability

Logit regression model was utilized to determine the factors affecting farmers' choice of adaptation strategies against climate variability. The decision to use adaptation measures was assumed to be a function of household characteristics (i.e. gender of HHH, age group of HHH, level of education, land size, type of farming, land under banana, farming system, access to market information, group membership, access to financial assistance, access to extension services, perception to climate variability, future information on weather and land ownership).

4.1.1 Socio-economic factors influencing farmers' choice of drought tolerant banana varieties

Logit regression model analysis of factors influencing bananas farmers' adaptation of drought tolerant banana varieties in Meru county showed that the model was significant at $p<0.01$ and correctly predicted 97.6% of both adopters and non-adopters to drought tolerant varieties as shown in Table 1. Five variables: Gender of HHH, farming system, land ownership, land under banana and access to financial services were significant in explaining the farmer's adaptation to drought tolerant banana varieties in Meru county. This concurs with studies that recommended planting more suitable and/or resilient crop varieties as one of the adaptation measures to mitigate the impact of climate variability (IPCC, 2007).This was further supported by studies conducted in Vihiga, which indicated that average yielding for dual-purpose sweet potato varieties together with improved livestock feed and breeds would fully offset the impacts of climate variability (Kelvin, et al, 2016). Similarly, Tachie-Obeng et al. (2012), found that introduction of heat-tolerant maize varieties would increase maize yields in Ghana.

Table 1.

Factors influencing bananas farmers' adaptation to drought tolerant banana varieties in Meru county

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
Agroecological Zone	0.256	1.529	0.028	0.867	1.291
Gender of HHH	-4.831*	2.704	3.192	0.074	0.008
Age group of HHH	0.524	0.446	1.377	0.241	1.688
Land under Banana	-29.587*	17.855	2.746	0.098	0.000
Farming System	-4.397*	2.497	3.103	0.078	0.012
Group membership	6.414	4.181	2.353	0.125	610.222
Land ownership	5.352*	3.007	3.168	0.075	210.947
Level of education	1.142	.970	1.387	0.239	3.133
Land size	0.071	0.047	2.322	0.128	1.074
Type of farming	-2.300	1.536	2.242	0.134	0.100
Access to market information	-0.291	0.380	0.588	0.443	0.747
Access to financial assistance	4.580*	2.576	3.162	0.075	0.010
Access to Extension services	1.859	1.648	1.272	0.259	6.418
Perception to climate variability	-5.316	4.134	1.654	0.198	0.005
Information on weather	-2.032	1.644	1.528	0.216	0.131

N=251, *Significant at 10% probability level

Gender of the household and land acreage under banana production negatively influenced farmers' adaptation to drought tolerant banana varieties at ($\beta=-4.831$, $p=0.074$) and ($\beta=-29.587$, $p=0.098$) respectively. This implies that male headed households and farmers who had small land area under banana production adapted to drought tolerant varieties as compared to those who possessed large farms under banana production. Male-headed households had a higher chance of adapting to drought varieties since they make important household decisions and own land rights. Men attend agricultural workshop and Baraza which disseminate information on new varieties. Marenya and Barrett (2007), for example, found that male-headed households had a higher propensity to adoption. The authors argued that inherent resource inequities between men and women play a big role and those inequities are caused by cultural conditions in many African societies which traditionally did not grant women secure entitlements to land and other property rights.

Land ownership positively (β=5.352, p=0.075), influenced adaptation strategies. Farmers who owned land adopted to drought tolerant banana varieties as compared to those who leased land. Farming system negatively influenced farmers' adaptation to drought tolerant banana varieties (β=-4.397, p=0.078). Farmers who relied on rain fed banana production adapted to drought tolerant banana varieties as compared to those who practiced irrigation and those who practiced both irrigation and rainfed banana production. Rain-fed banana farmers have limited options for commercial crop production. Given the over-reliance on rain fed agriculture, the opportunity exists to intensify production of drought tolerant banana varieties.

Access to financial services positively influenced farmers' adaptation to drought tolerant banana varieties (β=4.580, p=0.075). This implies that farmers who accessed financial services adapted more to drought tolerant banana varieties as compared to those who never accessed financial services. Farmers can be able to purchase those varieties from research institutions.

4.1.2 Adaptation to climate variability through crop diversification

Several factors were identified that influenced farmer's choice on crop diversification as a sustainable adaptation strategy to climate variability in Meru County. Logit regression model analysis of factors influencing bananas farmers' adaption to crop diversification showed that the model was significant at p<0.01 and correctly predicted at 87.6% of both adopters and non-adopters to crop diversification. Three variables: gender of HHH, change of crop under farming and farming system were significant in explaining the farmers' adaptation strategy to crop diversification in the study area (Table 2). This is supported by Shikuku et al (2017), who conducted studies in Machakos County, demonstrated that dual-purpose sweet potato variety in the cropping system would be sufficient to offset the negative impacts of climate variability.

Table 2.

Factors influencing bananas farmers' decision to adopt to crop diversification in Meru county

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
Gender of HHH	0.442**	0.788	2.873	0.004	0.875
Age group of HHH	0.895	0.136	0.301	0.583	1.078
Land under Banana	0.642	0.665	6.090	0.014	0.194
Farming System	-0.788**	0.473	21.236	0.007	0.113
Group membership	0.076	0.541	0.020	0.888	1.079
Land ownership	-0.889	0.857	0.499	0.480	0.442
Level of education	0.022	0.615	0.001	0.971	1.022
Access to market information	-0.291	0.380	0.238	0.473	0.547
Access to financial assistance	-0.291	0.863	0.896	0.807	0.799
Access to Extension services	-0.786	0.399	1.205	0.272	0.297
Perception to climate variability	0.078	0.452	0.011	0.409	1.780
Information on weather	0.740	0.800	0.059	0.862	0.678

N=251, ** Significant at 5% probability level, *Significant at 10% probability level

Gender of the household head positively (β=0.442, p=0.004) influenced farmers' adoption to crop diversification as an adaptation strategy to climate variability. Households dominated by females adapted to crop diversification as compared to male dominated households. This can be attributed by the fact that female diversify their source of livelihoods in order to provide food as well as source of income to basic household goods for the family. Farming system negatively influenced (β=-0.788, p=0.007), farmers' choice on adaptation strategy to climate variability. Farmers who practiced both rain-fed banana production preferred crop diversification as compared to farmers who practiced rain fed and irrigation. The farmers could intercrop the banana with other food crops to safeguard them in case one crop fails due to climate related issues such as water deficiency (Plate 1).

Plate 1. Examples of crop diversification in the study area (a) Banana and Irish potato; (b) Banana and maize; (c) Banana and beans; (d) banana and tobacco

According to Plate 1, farmers intercrop bananas with other food crops such as potatoes, maize and beans.

4.1.3 Socio-economic factors influencing adaptation to climate variability through shifting banana planting dates in Meru County

The result of the Logit model is presented in Table 3. The model was significant at p<0.01 and correctly predicted 98% of both on adopters and non-adopters to shifting banana planting dates. Banana planting should occur at the onset of the rainy season; the suckers needs 4-6months without water stress. Changes on the onset of the rainy season will shift the planting dates to avoid crop failures. Four variables; land under banana production, access to extension services, perception to climate variability and system of banana farming were significant in explaining the farmers' adaptation to shifting banana planting in Meru county.

Table 3.

Factors influencing farmers' choice on shifting banana planting dates as an adaptation strategy to climate variability in Meru county.

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
AEZ	0.321	0.957	0.112	0.738	1.378
Gender of HHH	0.730	1.028	0.504	0.478	2.074
Age group of HHH	0.228	0.475	0.230	0.632	1.256
Level of education	0.230	0.611	0.142	0.707	1.258
Land ownership	-0.875	0.951	0.845	0.358	0.417
Banana farming System	-1.635*	0.692	5.574	0.018	0.195
Land under Banana production	-0.561*	0.290	7.541	0.008	2.162
Group membership	0.691	0.352	3.848	0.450	1.996
Access to financial assistance	0.221	0.564	0.154	0.695	1.248
Access to Extension services	-0.906*	0.209	8.085	0.064	0.490
Perception to climate variability	0.325**	0.876	0.654	0.045	1.770
Information on weather	0.298	0.426	2.290	0.791	1.058

N=251, ** Significant at 5% probability level, *Significant at 10% probability level

Land size under banana production negatively (β=-0.561, p=0.008) influenced farmer's choice on shifting banana planting dates as an adaptation strategy to climate variability. This implies that farmers who controlled and owned large pieces of land under banana production adapted to shifting banana planting dates as compared to farmers who has small size of land under banana production. Large farm size facilitated shifting of the planting dates in some portions of the land. Farming system negatively (β=-1.635, p=0.018) influenced farmer's choice on shifting banana planting dates as an adaptation strategy to climate variability. Farmers who practiced rain fed banana production preferred shifting banana planting dates as an adaptation strategy.

Access to weather information positively (β=0.416, p=0.068) influenced farmer's choice on shifting banana planting dates as an adaptation strategy to climate variability. This infers that access to weather information influenced farmers' choice on adaptation strategy. Farmers who accessed weather information adopted to shifting in planting dates, whereas those farmers who never accessed such information never adopted to this strategy. Access to extension services among banana farmers negatively (β=-0.906, p=0.064) influenced farmer's choice on shifting banana planting dates as an adaptation strategy to climate variability. Farmers who accessed extension services adapted to shifting in planting dates, whereas those farmers who never accessed such services never adapted to this strategy. This can be explained by the fact that extension officers create awareness to the farmers and give agricultural advice which is trusted.

Studies conducted in East African countries showed that farmers preferred changing land preparation or planting dates in order to reduce climate related risks (Kelvin et al., 2016). A possible explanation for this could be that such practices require little investment to implement involving only seeking information and training whereas many of the other practices require large investments in time and money.

4.1.4 Socio-economic factors influencing adaptation to climate variability through irrigation in Meru County

The result of Logit model is presented in Table 4. The model was significant at p<0.01 and correctly predicted 93.5% of both adopters and non-adopters to bananas irrigation. Four variables; land size under banana production, access to extension services, access to financial facilities, agroecological zone and perception to climate variability were significant in explaining the farmers' adaptation to irrigation in Meru County.

Table 4.

Factors influencing farmers' choice on irrigation as an adaptation strategy to climate variability in Meru County

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
AEZ	-1.219**	0.573	4.524	0.033	0.296
Gender of HHH	0.252	0.591	0.182	0.670	1.286
Age group of the HHH	-0.482*	0.263	3.353	0.067	0.617
Level of education	-0.282	0.401	0.495	0.482	0.754
Land ownership	-1.849	1.415	1.707	0.191	0.157
Land size	-0.026	0.042	0.375	0.540	0.981
Land under Banana production	-0.771**	0.279	7.611	0.006	2.162
Type of farming System	2.167	0.416	27.186	0.675	8.734
Group membership	1.292	0.913	2.005	0.157	3.642
Access to financial facilities	0.221**	0.564	0.154	0.046	1.248
Access to Extension services	-0.766	0.974	8.445	0.784	0.905
Perception to climate variability	-0.275**	0.626	0.982	0.035	1.907
Information on weather	0.229	0.426	0.29	0.591	1.258

N=251, ** Significant at 5% probability level, *Significant at 10% probability level

Agro-Ecological Zone (AEZ) positively (β=1.219, p=0.033) influenced adaptation to irrigation as an adaptation strategy. Farmers who practiced banana production in lower humid (LH) zones adapted irrigation as an adaptation strategy as compared to those in Lower midland (LM) zone since LH zone receives low rainfall. Age of the household head positively (β=-0.482, p=0.067) influenced irrigation as an adaptation strategy. Household heads who were young easily adapted to irrigation since they were strong and irrigation is labour intensive enterprise.

Access to financial facilities positively (β=0.221, p=0.046) influenced adaptation strategy to irrigation. Households with access to financial facilities adapted to irrigation as an adaptation strategy. Irrigation requires capital investment which has financial implications. Establishing links with banks and microfinance institutions which provide credit and loans facilities to farmers to invest on irrigation equipments is important. Bryan et al. (2013) in his studies found that, although farmers were interested to irrigation as an adaptation strategy it required greater investments and potentially hold positive returns in terms of banana productivity. Moreover, the risks associated with availability or future access of resources such as water and land might reduce the likelihood of adaptation through irrigation within the region (Lee, 2005). Research on adoption of agricultural technologies show that there is a positive relationship between the level of adoption for this irrigation and the availability of credit (Yirga, 2007).

Land under banana production negatively (β=-0.771, p=0.006) influenced adaptation strategy. Farmers who had small land size under banana production adapted to irrigation as compared to those farmers who large track of lands. Access to extension services to banana farmers negatively (β=-0.766, p=0.004) influenced adaptation strategy, indicating that farmers who accessed extension services on banana production adapted to irrigation as compared to those farmers who never accessed extension services. This can be explained by the awareness and skills gained from the extension officers on irrigation as an alternative to rainfed irrigation. Through workshops and seminars, farmers are usually trained on the irrigation as means of increasing productivity despite climate challenges.

Perception to climate variability negatively (β=-0.275, p=0.035) influenced farmers' choice on adaptation strategy. Farmers who perceived climate variability effects on banana production adapted to irrigation as a strategy. Farmers treasure irrigation as the option to unreliable and unpredictable rains within the region. Investments in irrigation projects offer opportunity to address water shortages in the light of climate variability. This further guarantees high yields and all year-round harvest.

5. Conclusion

The adaptation strategies to climate variability identified by the farmers in this study included planting of drought tolerant banana varieties, crop diversification, shifting planting dates and use of irrigation to enhance production. The study realized that irrigation and shifting banana planting dates were the most preferred adaptation strategies by banana farmers in the region. Socio-economic factors influencing adaptation to climate variability through adopting to drought tolerant banana varieties were gender of the HHH, farming system, land ownership, land under banana production and access to financial services while gender of HHH, variability of crop under farming and farming system were significant in explaining the farmer's adaptation to crop diversification in the study region. Land under banana production, access to extension services, perception to climate variability and system of banana farming were significant in explaining the farmer's adaptation to shifting banana planting dates while land under banana production, age of the household head, access to extension services, access to financial facilities, agro-ecological zone and perception to climate variability were significant in explaining the farmers' adaptation to irrigation.

The county and national government should provide resources (funds and human resource) to the small holder's farmers to support irrigation. Farmers should not over depend on river water as source of irrigation water but other options should be explored. Irrigation water should be managed through the community's projects to offer accessible and sustainable provision of water. In order to address the small holders' constraints, providing climate information to farmers is critical. This will enhance sustainable adaptations to climate variability impacts such as irrigation, promoting crop diversification and encouraging adoption of drought tolerant banana varieties thus enhancing resilience of farming systems in the short-term.

At a lower level, policies that generate incentives for formation and active participation in farmers' groups should be encouraged in the efforts to boost information sharing and promoting competitive marketing of the banana produce. Equally important are policies aimed at improving the livelihood status of the household as this might increase innovativeness and contribute to improved overall adaptation. Providing social safety nets are useful at lower levels of adaptation such as provision of drought resistance varieties. At higher levels of adaptation, efforts to ease liquidity constraints by increasing access to credit are required.

Alternative climate smart crops should be introduced to diversify the crops grown and this should be encouraged to avoid relying on banana which might be vulnerable to climate variability. Additionally, concerted efforts in sharing information among the various stakeholders regarding the planning and implementation of climate risk management strategies are needed to improve efficiency and effectiveness of interventions. Access to comprehensive market information is essential for development of agricultural marketing; the public sector should support provision of market information to improve on market transparency. There is also need for the public agricultural extension service providers to integrate market information in their routine extension messages.

References

Bruin, K. (2011). An Economic Analysis of Adaptation to climate Change under Uncertainty. Unpublished Doctoral Dissertation, University of Wageningen, the Netherlands.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., & Herrero, M., (2013). Adapting agriculture to climate change in Kenya: Household strategies and determinants. J. Environ. Manage. 114: 26–35.

Deressa T., Hassan, C., Ringler, Tekie. A., & Mahmud, Y., (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. Global Environmental Change, 19: 248-255.

Di Falco, S., (2014). Adaptation to climate change in Sub-Saharan agriculture: Assessing the evidence and rethinking the drivers. Eur. Rev. Agric. Econ. 41 (3):405–430.

Di Falco, S., and Veronesi, M., (2013) How can African agriculture adapt to climate change? A counterfactual analysis from Ethiopia. Land Econ. 89 (4):743–766.

Esham, M., and Garforth C., (2013). Agricultural adaptation to climate change: insights from a farming community in Sri Lanka. Mitigation and Adaptation Strategies for Global Change.;18(5): 535-549.

FAO, (2004). The State of Food and Agriculture. Rome

Frison E, Escalant J and Sharrock S (2004) The global Musa genomic consortium: a boost for banana improvement. In: Jain S M, Swennen R (eds) Banana. Improv. Cell. Mol. Biol. Induc. Mutat. Proc. a Meet. held Leuven, Belgium, 24-28 Sept. 2001. Science Publishers, Inc., pp 341–349

Gbetibouo, G., (2009). Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa. IFPRI Discussion Paper, 36.

GOK, (2015). County statistical abstract, Meru County, KNBS Nairobi.

GOK, (2012). Ministry of Agriculture Validated Report 2012, Karuri Ventures, Nairobi

GOK, (2009). Kenya Population and Housing Census (KPHC). Government of Kenya, Kenya National Bureau of Statistics, Nairobi, Kenya.

ILRI, (2007). Annual Report 2007 Markets that Work: Making a Living from Agriculture.
International Livestock Research Institute, Nairobi, Kenya.

IFAD, (2010). Climate change impacts, South Asia, httP://www.ifad.org/ events/apr09/impact/seasia.pdf (last access: 21 June 2016).

INIBAP. (1996). Major banana and plantain types cultivated around the world, Pp. 23-25 in The
global banana and plantain network: INIBAP annual report 1994. INIBAP, Montpellier,
France.

IPCC, (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland,

IPCC, (2007). Climate Change 2007: Synthesis Report Fourth (AR4) Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). M.L. Geneva.

Jaetzold, R., Schmidt, H., Hornez, D., & Shisanya, C. (2006) Farm Management Handbook of Kenya Vol 2 Natural Conditions and Farm Management Information Part B, Central Kenya 2nd Ed, Ministry of Agriculture Publisher, Nairobi

Kabubo-Mariara, J & Karanja, F., (2007). The economic impact of climate change on Kenyan crop agriculture: a Ricardian approach, Glob. Planet. Change 57 (3):319–330, http://dx.doi.org/10.1016/j.gloplacha.2007.01.002

Kamau, M., Olwande, J.. & Githuku J., (2011). Consumption and Expenditures on Key Food Commodities in Urban Households: The Case of Nairobi. Tegemeo Working Paper 41. Nairobi; Tegemeo Institute, Egerton University.

Kelvin, M., Leigh, W., Jennifer, T., Anton, E., Juan G., Mwongera C., & Peter L., (2016). Smallholder farmers' attitudes and determinants of adaptation to climate risks in East Africa, Journal of climate Risk Management 16:234–245 journal homepage: www.elsevier.com/ locate/crm

Lee, D., (2005). Agricultural sustainability and technology adoption: issues and policies for developing countries. Am. J. Agric. Econ. 87 (5):1325–1334.

Magombo, T., Kantlini, G., Phiri, G., Kachulu, M., & Kabuli, H. (2011). Incidence of Indigenous and Innovative Climate Change Adaptation Practices for Smallholder Farmers, Livelihoods Security in Chikhwawa District, Malawi. African Technology Policy Study Network, Research Paper No: 14.

Marenya, P., & Barrett, C., (2007). Household-level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya. Food Policy 32: 515–536.

Micah, B., & Absalom, M., (2014). Factors Influencing the Choice of Climate Change Adaptation Strategies by Households: A Case of Mpolonjeni Area Development Programme (ADP) in Swaziland. Journal of Agricultural Studies ISSN 2166-0379 2014, Vol. 2, No. 1

Nhemachena, C., & Hassan, R., (2008). Micro-level analysis of farmers' adaptation to climate change in Southern Africa. IFPRI Discussion Paper No. 00714. International Food Policy Research Institute. Washington DC.

UNFCCC, (2009). Report of the Conference of the Parties on its fifteenth session, held in Copenhagen from 7 to 19 December 2009; Part Two: Decisions Adopted by the Conference of the Parties.

Ramirez, J., Jarvis, A., Van den Bergh, I., Staver, C., & Turner, D. (2011). Changing climates: effects on growing conditions for banana and plantain (Musa spp.) and possible responses. Crop adaptation to climate change, 19:426-438.

Shikuku, K., Winowiecki, L., Twyman, J., Eitzinger, A., Pérez J., Juan G., Mwongera, C., & Laderach, P., (2017). Smallholder farmers' attitudes and determinants of adaptation to climate risks in East Africa. Climate Risk Management journal. 16:234-245. 10.1016/j.crm.2017.03.001

SPSS, I. (2012). IBM SPSS statistics version 21. Boston, Mass: International Business Machines Corp, 126.

Tachie-Obeng, E., Akponikpe, P., & Adiku, S., (2012). Considering effective adaptation options to impacts of climate change for maize production in Ghana. Environmental Development 5: 131–145 http://dx.doi.org/10.1016/j.envdev.2012.11.008.

World Bank, (2010). The Economics of Climate Change. A Synthesis Report. Final Constitution Draft. EACC.

Wik, M., Pingali, P., & Brocai, S, (2008). Global Agricultural Performance: Past Trends and Future Prospects. Washington, DC: World Bank.
https://openknowledge.worldbank.org/handle/10986/9122 accessed on 9th October 2018

Yesuf, M., Falco, S., Deressa, T., Ringler, C., & Kohlin, G. (2008). The impact of climate change and adaptation on food production in low-income countries. Evidence from the Nile Basin, Ethiopia Intl Food Policy Res Inst.

Yirga, C., (2007). The dynamics of soil degradation and incentives for optimal management in Central Unpublished PhD Thesis (Environmental Economics), University of Pretoria.