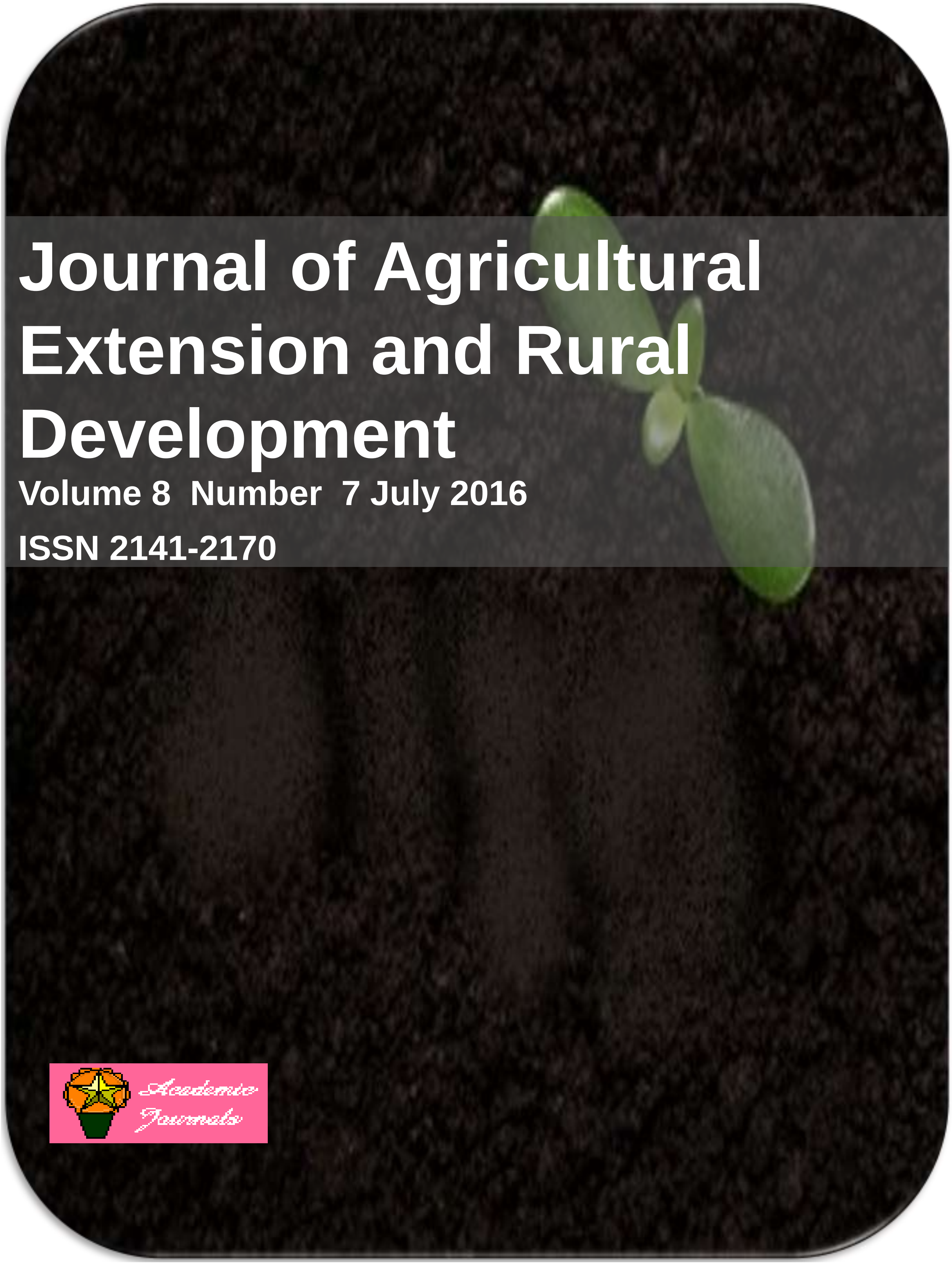

Journal of Agricultural Extension and Rural Development

Volume 8 Number 7 July 2016

ISSN 2141-2170

Academic Journals

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Journal of Agricultural Extension and Rural Development

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academicJournals

Vol.8(7), pp. 111-121, July 2016
DOI: 10.5897/JAERD2016.0769
Articles Number: 653ED8E59128
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Factors affecting weather index-based crop insurance in Laikipia County, Kenya

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Received 2 February, 2016; Accepted 4 May, 2016

Weather Index-based Crop Insurance (WII) scheme have been introduced as an innovative way of mitigating downside risk effects, especially for smallholder farmers in developing countries. The uptake and effectiveness of such a scheme, especially in Kenya is not well documented. A stratified random sampling procedure was employed to get a representative sample of 330 smallholder farm households. This paper uses a double hurdle model to establish factors influencing adoption and the eventual extent of uptake of a weather-based crop insurance, what in Kenya is referred to as *Kilimo Salama* meaning safe farming in English. The results show that, access to extension, perception and group membership had significant positive effects on adoption (at 1% level), household head education level (at 5% level) whilst, adoption was negatively influenced by distance to agrovet and distance to the extension agent office (at 1% level), farming experience, age of household head and size of cultivated land (at 10% level). Distance to agrovet negatively influenced extent of adoption at 1% level while distance to extension agent together with farm size positively influenced the extent of adoption at 5 and 10% level respectively. To enhance participation by farmers in *Kilimo Salama* insurance scheme and consequently reduce production risks in their farming business, interventions that would enable farmers access to agricultural information, membership to groups, reduction of transaction costs and training farmers on benefits of an insurance scheme should be encouraged.

Key words: *Kilimo Salama*, adoption, double hurdle model, crop insurance, Kenya.

INTRODUCTION

A majority of smallholder farmers employ informal risk management strategies such as income diversification, borrowing from money lenders, selling assets, participating in off-farm work and in government as well as non-government relief programmes (Hardaker et al., 2004). However, these traditional risk management strategies have the limitation of co-variability problem (Gautam et al., 1994). Co-variability problem is a situation that traditional risk management strategies may involve more cost. For example, diversification pursued as a risk management reduces average income, credit borrowed in drought years must be repaid with interest while

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JEL: D130, D810, Q120, Q140, Q180.

temporarily liquidating assets is costly due to capital losses. Therefore, there is a need for innovative risk management strategy such as Weather - Index Insurance (WII).

Weather-Index Insurance (WII) is an innovative form of index insurance that covers farmers against weather-related extreme events. The technology uses a proxy (or index) – such as the amount of rainfall, or temperature, or wind speed - to trigger indemnity payouts to farmers. This index helps to determine whether farmers have suffered losses from the insured peril and hence need to be compensated (World Bank, 2011; Tadesse et al., 2015). The *Kilimo Salama* insurance application of WII is against rainfall deficits, including drought, based on rainfall measurements at reference weather stations during a defined period. In this scheme, insurance payouts are made based on a pre-established indemnity scale set out in the insurance policy. Here, the sum insured is based on the production costs for the selected crop, and indemnity payments are made when actual rainfall in the current cropping season, as measured at a selected weather station, falls below pre-defined threshold levels or exceeds it (Sina, 2012).

The WII empowers the rural communities, especially the smallholder farmers to cope with increasing livelihood vulnerabilities through maintaining stability in farm income, promoting technology adoption, encouraging investment, and increasing credit flow to the agricultural sector (Hess and Syroka, 2005; Skees and Barnett, 2006). In both developed and developing countries WII technology has gained attention because its contracts are relatively simple in implementation, sales and marketing (Barnett and Mahul, 2007). Further, the technology reduces adverse selection and moral hazard. Therefore, neither sellers nor the buyers of the insurance scheme can influence its realization (Giné et al., 2005). Despite the advantages associated with the technology, WII's are expensive to start and suffers from basis risk. Basis risk is a situation that what is predicted by the index differs from farmers' experiences in some regions under insurance cover (Hess, 2003; Collier et al., 2009).

In the face of increasing uncertainty and risk faced by the farming community associated with climate change, a private insurance scheme in Kenya, the *Kilimo Salama* insurance evolved in the year 2008. *Kilimo Salama* a Kiswahili phrase meaning safe farming in English is a kind of weather index crop insurance scheme. The scheme aimed to protect farmers against drought and excess rainfall risks, in particular, protecting their investment in input (seeds, fertilizer, and crop chemicals). in which the premium was bundled in input bought. Farmers are therefore guaranteed some compensation in case of harsh conditions. The scheme uses solar-powered weather stations to monitor rainfall and mobile phone payment technology to collect premiums and make payments to farmers. An indemnity is paid whenever the realized value of the index report drought or excess rainfall in the farmers' registered weather station (Sina, 2012). The scheme was launched by Syngenta Foundation for Sustainable Agriculture in partnership with the insurance company UAP and the telecommunication Safaricom. The pilot phase of *Kilimo Salama* insured 200 maize farmers in Nanyuki in Laikipia County (Stutley, 2012, quoted in WFP- IFAD 2010). Currently, it has spread to Nyanza, Eldoret, Busia, Embu, and Kitale. Despite the existence of *Kilimo Salama* insurance scheme in Kenya, there exists an empirical knowledge gap on factors affecting its adoption and extent of adoption.

Past empirical studies on WII have focused on the evaluation of factors influencing demand and participation in the insurance programmes. For example results of several studies reveal that the age and education level of the farmer, and trust positively influence the demand for crop insurance (Smith and Baquet, 1996; Goodwin and Mishra, 2006; Boyd et al., 2011; Velandia et al., 2009). To the contrary, there was negative relationship between farmers' age and their family size with the adoption of crop insurance indicator (Sadati et al., 2010). While Velandia et al. (2009) reported off-farm income to influence demand for crop insurance positively, Sakurai and Reardon (1997) reported a negative influence. Credit constraint influence demand for crop insurance negatively (Giné et al., 2008; Giné and Yang, 2009; Cai et al., 2009).

From the reviewed literature, none of the studies attempted to determine both factors that influence adoption and extent of adoption of crop insurance together. In assessing the performance of any agricultural technology, it is important to understand the factors that influence adoption process and the extent to which technologies have spread throughout the target population. Also, understanding the factors that influence adoption of an insurance scheme is important in coming up with relevant evidence-based policies regarding formal agricultural crop management strategy as well as enhancing its uptake by farmers. Similarly, insurance providers, on the other hand, may be able to determine the economic gain associated with their investment against this backdrop.The objective of this study was to determine factors that influenced the decision to adopt as well as the extent of adoption of *Kilimo Salama* insurance scheme using the Cragg‟s double hurdle model. The postulated hypothesis of the study was that socio-economic, institutional and technological factors do not influence the participation and extent of the insurance scheme.

METHODOLOGY

The study area

This study was conducted in Daiga and Lamuria divisions of Laikipia East Sub-county in Laikipia County because they are the two divisions where *Kilimo Salama* insurance scheme was piloted in 2008. The divisions are situated within the transitional zone of wetter and drier rainfall regime. The rainfall ranges between 280 and 1100 mm per annum in Daiga and Lamuria receive an average rainfall of 1024 and 787 mm per annum, respectively. The rainfall pattern is bi-modal with the long rains occurring from March to May and short rains from October to November (Gichuki et al., 1998). The divisions also experience continental rains (rain caused by the Congo airstream) which occur between June and September (Jaetzold et al., 2005). Daiga and Lamuria are classified as semi-humid and semi-arid zones with an elevation of 2020 and 1840 m above mean sea level (msl), respectively.

The dominant livestock in the County are cattle, sheep and goats while the dominant crops grown are maize and beans planted by almost all farmers. Other crops are potatoes, peas, sweet potatoes, cabbages, kales, and peas. Maize is a staple food in both divisions, and its production is affected periodically by inadequate and poorly distributed rainfall. The weather index crop insurance known as *Kilimo Salama* was initiated in the divisions in 2008 to mitigate against production risks and improve food security status.

Sampling and data collection

A sample of 330 households was obtained through a stratified random sampling procedure from Laikipia County. The sample comprised of 130 adopters and 200 non-adopters of *Kilimo Salama* insurance scheme. The non- adopters considered were about a 5 km radius from adopters to take care of spillover effects. To get the adopters of the insurance scheme, a list of households who adopted the insurance at the pilot stage was developed. This was possible with the help of the chairpersons of the groups whose members had adopted the insurance scheme. For the non-adopters, a systematic random sampling was used. A random route, in this case, the roads were used along which every third household to the right and then to the left were selected and interviewed by the enumerators. A stratified sampling method was preferred to get control of the sample and to enable replacement of household from the same strata.

Primary data were collected using pre-tested questionnaires that were administered through face-to-face interviews between April and May 2012. Data collected were on household demographic, socio-economic and institutional characteristics postulated to have an influence on adoption of *Kilimo Salama* insurance scheme. Data on the amount of inputs bought from the insurance scheme and other sources were also collected. The extent of adoption was determined by computing a ratio of cost of inputs bought from insurance scheme relative to total cost of inputs used in the farm in two cropping seasons in the year 2011.

Theoretical framework and variable description

Assuming that smallholder agriculture is rain-fed and those smallholder farmers are rational but exhibit risk-averse behaviour, and then it follows that the smallholder farmers would be willing to participate in *Kilimo Salama* insurance scheme. Consequently, the indirect utility function for respondent *j* can be specified as (Equation 1):

$$V_{ij} = V_i(m_j, h_j, \varepsilon_{ij}) \quad (1)$$

where V_{ij} is the utility function, m_j is the production function of the j^{th} household, h_j represents a vector of household characteristics and choice attributes such as age, education, farming experience and input costs, and ε_{ij} a random error unobserved component of utility.

In this study, i = 0 indicated production occurring without drought insurance and i = 1 is a proxy indicator for production where farmers have adopted *Kilimo Salama* insurance. In a case where household *j* has adopted *Kilimo Salama* insurance scheme, indicating payment of a premium t_j to insure, it follows that the utility received on insuring is higher than when there is no insurance (Equation 2).

$$V_1(m_j - t_j, h_j, \varepsilon_{1j}) > V_0(m_j, h_j, \varepsilon_{0j}) \quad (2)$$

where V_1 is the utility function incorporating willingness to pay for crop insurance, m_j-t_j is production with insurance, *hj* represents a vector of household characteristics, and choice attributes and ε_{ij} is a random error term while V_0 is the utility derived by the farmer with no insurance, m_j is production without insurance, and ε_{0j} is a random error term without the insurance. If the utility $V_1 - V_0 > 0$, a farmer will prefer to adopt *Kilimo Salama* insurance scheme. Thus, the difference between the expected utility production with the insurance and without the insurance is the potential factors determining farmers' decision of *Kilimo Salama* insurance adoption.

To determine factors that influence adoption of improved agricultural technologies in Kenya numerous studies have utilized the Logit, Probit or Linear probability models (Mwabu et al., 2006; Amudavi et al., 2008; Nambiro and Okoth, 2013). The biggest shortcoming of Probit and Logit models is that they do not measure the extent of technology adoption (Feder et al., 1985). The decision whether to adopt a technology such as *Kilimo Salama* insurance scheme and extent of adoption can be made jointly or separately. In this case, the Heckman two- stage, the Tobit and the Double hurdle model can be used. Several studies have used the Heckman two-stage model to determine probability and extent of adoption of agricultural technologies (Wachira et al., 2012; Kinuthia et al., 2011; Ramaekers et al., 2013). The model, posses a characteristic of the first hurdle dominance; a condition in which the adoption decision receives greater importance than the extent decision yet both decisions are equally important.

In a situation where the decision to adopt and extent of adoption are made jointly and affected by same factors then the Tobit model would be appropriate for analysis (Greene, 1993; Ouma and De Groote, 2011; Murage et al., 2012). Thus, if a given factor leads to whether to adopt then this factor has a positive effect on how much to adopt. However, there may be a proportion of the population of farmers who would because they will be negatively affected by adopting insurance scheme, never adopt under any circumstances (Moffatt, 2005). In such a case, a model such as the Tobit might be too restrictive because it allows one type of zero observation, namely a corner solution since it is based on the implicit assumption that zeros arise only as a result of the respondent's economic circumstances (Martínez-Espiñeira, 2006).

Berhanu and Swinton (2003) argued that adoption and extent decisions are not necessarily made jointly. The decision to adopt may precede the decision on the extent of use, and the factors affecting each decision may be different. With this reasoning, the appropriate model to analyse factors that affect probability and extent of adoption is the double hurdle model. The Double hurdle model was first suggested by Cragg (1971) to solve the restriction of too many zeros in Tobit model and has been used by several authors (Moffatt, 2005; Burke, 2009; Olwande et al., 2009; Mignouna et al., 2011). The underlying assumption in the double-hurdle approach is that individuals make two decisions about their willingness to adopt *Kilimo Salama* insurance scheme. The first decision is whether they will buy insured inputs while the second decision is about the amount of the insured inputs they will buy, conditional on the first decision. The importance of treating the two decisions independently lies in the fact that factors that affect one's decision to adopt may be different from those affecting the decision on how much to adopt. Implying that households must cross two hurdles to adopting and therefore, the first hurdle needs to be met to be a potential adopter. Furthermore, this model approach allows us to understand characteristics of a class of households that would never adopt *Kilimo Salama* insurance scheme. Thus, the probability of a household to belong to a particular category depends on a set of household's characteristics.

The double hurdle model is, therefore, superior in comparison to other models that are used in adoption decisions especially Tobit, which assumes that the two decisions are affected by the same factors. With this respect, to achieve the objective of the study, a double hurdle model was preferred. The model consists of two hurdles representing two sequential decision-making process. The two decisions are whether to participate in *Kilimo Salama* insurance scheme and to what extent. The extent of adoption was considered as the ratio of insured inputs to the total inputs bought by each household. The households must cross two hurdles to be considered as adopters. Each hurdle is conditioned by household socio-economic and demographic characteristics (e.g., age, education and farm size) and *Kilimo Salama* attributes (access to information about the scheme, premium for inputs and distance to registered agrovet). Non–economic factors can condition the attainment of the first hurdle while economic factors are important to determine a positive outcome of the second hurdle.

In the first hurdle, the Probit model was used to determine the probability that a household could adopt *Kilimo Salama* insurance scheme and a Tobit model to determine the extent of adoption. In double hurdle model, whether a household has adopted *Kilimo Salama* (a dichotomous choice) and the extent of adoption that is, the cost of input bought (a continuous variable); Double hurdle is a parametric generalization (Equation 3 and 4).

The first equation relates to the decision to adopt (y) can be expressed as (Mignouna et al., 2011):

$$y_i = 1 \; if \; y_i^* > 0 \; and \; 0 \; if \; y_i^* \leq 0 \quad (3)$$

$$y_i^* = x_i^{'} \alpha + \varepsilon_i \quad (4)$$

where: y_i^* is a dependent dichotomous choice adoption variable that takes the value of 1 if a household adopted *Kilimo Salama* and 0 otherwise, *x'* is a vector of household characteristics and α is a vector of parameters for the first hurdle. The second hurdle which closely resembles the Tobit is expressed as:

$$t_i = t_i^* > 0 \; and \; y_i^* > 0 \quad (5)$$

t_i^* = 0 otherwise

$$t_i^* = z_i^* \beta + \mu_i \quad (6)$$

where: t_i is the dependent variable for the extent of adoption of Kilimo *Salama* insurance scheme equation conditional on y_i =1. *z* is a vector of the household characteristics and *β* is a vector of parameter for the second hurdle. The respective errors (μ_i and ε_i) are assumed to be independent (not correlated) and normally distributed according to Goodwin and Smith (2003) (Equation 7).

$$\mu_i \sim N\,(0,1), \varepsilon_i \sim N\,(0, \partial^2) \quad (7)$$

The observed variable in a Double hurdle model is:

$$t_i = y_i t_i^* \quad (8)$$

The empirical adoption model estimated in the first hurdle (Probit model) was as follows:

$$\begin{aligned} ADOPT = {} & \beta_0 + \beta_1 AGROVET + \beta_2 DEXTNS + \beta_3 LANDHA + \beta_4 CREDIT + \beta_5 FARMEXP + \\ & \beta_6 GROUP + \beta_7 SEXHHED + \beta_8 AGEHHED + \beta_9 AGEC2 + \beta_{10} EDUHHED + \\ & \beta_{11} CUTVHA + \beta_{12} NUMBERHM + \beta_{13} WRK - FRC + \beta_{14} TENURE + \\ & \beta_{15} NTEXTNS + \beta_{16} PERCEP + \varepsilon_i \end{aligned} \quad (9)$$

The dependent variable *ADOPT* refers to whether a farmer had bought insured inputs and was dichotomous. The independent variables are described in Table 1.

The extent empirical model, second hurdle (Tobit model) was estimated as shown:

$$\begin{aligned} EXTENT = {} & \beta_0 + \beta_1 AGROVET + \beta_2 DEXTNS + \beta_3 LANDHA + \beta_4 CREDIT + \beta_5 FARMEXP \\ & + \beta_6 GROUP + \beta_7 SEXHHED + \beta_8 AGEHHED + \beta_9 AGEC2 + \beta_{10} EDUHHED + \\ & \beta_{11} CUTVHA + \beta_{12} NUMBERHM + \beta_{13} WRK - FRC + \beta_{14} TENURE + \\ & \beta_{15} NTEXTNS + \beta_{16} PERCEP + \beta_{17} OFF - FARM + \varepsilon_i \end{aligned} \quad (10)$$

The dependent variable in the second equation (*EXTENT*) refers to the ratio of the insured inputs to the total inputs bought by the household. Description of independent variables used are shown in Table 1.The study estimated the unconditional average partial effects (APE), and run bootstrapping replications on each observation. Determination of APE helps in estimating the observed coefficient, standard errors and the P-values showing the significance levels described by Burke (2009).

EMPIRICAL RESULTS

Descriptive results

Table 2 presents the descriptive statistics of demographic, socio economic and institutional characteristics of sampled farmers.

The average land size was 1.2 ha, and only 0.93 ha was under cultivation. The latter accounted for about 75% of the total land size under cultivation. Adopters owned a mean land size of 1.3 while non-adopters owned 1.2 ha. There was a significant difference in mean land size owned between adopters and non-adopters at 10% significance level. However, there was no significant difference in cultivated land size between adopters and non-adopters.

Years of education of household heads ranged from 0 years (no formal) to 15 years of education with a mean of 6.8. Education level varied among household heads with a standard deviation of 5.98. Education level was statistically different between adopters and non-adopters of *Kilimo Salama* at 1% level of significance. The percentage of literate adults in the population was about 84.5% and was relatively higher than the national average of 79.5% (GoK, 2007). The age of household heads' ranged from 28 to 82 years with an average age of 54.23 years having a standard deviation of 11.15.

There was no statistical difference in age between adopters (53.8) and non-adopters (54.5).

The results showed that on average, the household size (NUMBERHM) of the sample in the study areas was four persons while individually ranging from 1 to 8 persons per household. The mean family size in the study areas (4 persons per household) is relatively lower than the

Table 1. Description, measurement and hypothesized effects of the variables in the model.

Variables	Description of variables	Sign	Hypothesised effect
ADOPT	Whether the household head adopted *Kilimo Salama* insurance		
EXTENT	Ratio of the amount of input from *Kilimo Salama*/total inputs bought in the farm		
PERCEP	Perception towards *Kilimo Salama* (0= poor, 1= fair, 2= average, 3= good, 4= excellent)	+	The higher the perception rate, that is, “excellent”, the higher would be the probability and the extent of adoption (Adesina and Baidu-Forson, 1995 and Adesina and Zinnah (1993)
LANDHA	Total amount of land owned or rented by a household (Hectares)	+	Large farm size is associated with greater wealth, increased availability of capital and high risk bearing (Genius et al., 2006).
EDUCHHED	Household’s head years of schooling (Years)	+	Education enhances the ability to understand the benefits of *Kilimo Salama* insurance scheme (Bekele et al., 2000).
AGEHHED	Age of household head (Years)	+/-	Young farmers are more open to change and hence eager to adopt *Kilimo Salama* insurance (Adesina and Baidu- Forson, 1995). However, young farmers may have lower income and wealth, limited access to credit hence less likely to adopt insurance (Langyintuo and Mekuria, 2005; Bagheri et al., 2008 and Velandia et al., 2009).
NUMBERHM	Number of people in household (Persons)	+	Households with large numbers have more labour and need more food thus willing to adopt *Kilimo Salama* to increase production (Abdulai et al., 2008).
SEXHHED	Gender of household head (1=male, 0=female)	+	Men are more likely to access resources and information for insurance adoption (Adesina et al., 2000 and Kaliba et al., 2000).
WRK-FRC	Members of household who could offer labour (between 18-65 years).	+	A high work-force implies that some members could be involved in off-farm activities, earn income which could be vital in the adoption
NTEXTNS	Frequency the household head contacted government extension agent (Number)	+	Extension expose people to information that reduces subjective uncertainty about a technology such as *Kilimo Salama* insurance (Adesina and Baidu – Forson,1995 and Degnet et al., 2001)
CUTVHA	Size of land cultivated (Hectares)	+	The larger the cultivated land the higher the rate of adoption
FARMEXP	Household head years of experience in farming	+	Farming experience promotes the adoption of improved technologies (Maddison, 2006; Nhemachena and Hassan, 2007). More farming experience makes it easier to identify the best risk management strategy such as *KilimoSalama* insurance scheme
DEXTNS	Distance to the agricultural offices (Kilometres)	-	Long distance to the extension translates to poor access to information
AGROVET	Distance to the *Kilimo Salama* registered agrovets in Nanyuki Town. (Kilometres).	-	The proximity of the agent to the farmer’s homestead reduces transaction costs and time that a farmer spends
GROUP	Household head’s membership to farmer group (1= yes, 0= no)	+	Groups may expose individuals to access financial assistance and information about an innovation and causing subsequent adoption (Ndunda and Mungatana, 2013)
CREDIT	Access to credit facilities (1= yes, 0= no)	+/-	Credit enables access to required farm inputs (Feder et al., 1985 and Pattanayak et al., 2003). Conversely, credit act as a substitute for insurance scheme in risk management.
AGE2	Age of household head squared (Years)	-	Adoption rate is anticipated to decrease when farmers are very old

Table 1. Cont'd

OFF-FARM	Income earned outside the farm (1= yes, 0= no)	-	Off-farm income can be saved and used to manage production risks
TENURE	1 = farmer has secure tenure rights	+	Ownership of land implies security and motivates adoption.

Table 2. Descriptive statistics of demographic, socio-economic and institutional characteristics.

Variable	Min.	Max.	Mean	Full	Adopters	Non adopters	χ^2	*t*-value
Socio-economic characteristics								
LANDHA	0.10	6.07	1.24 (0.74)	1.2 (0.04)	1.3 (0.8)	1.2 (0.7)		1.747*
EDUCHHED	0	15	6.77 (5.98)	6.8 (6.0)	8.1 (4.0)	6.8 (5.9)		3.327***
Demographic characteristics								
AGEHHED	28	82	54.23 (11.15)	54.2 (11.15)	53.8 (11.1)	54.5 (11.2)		-0.631
NUMBERHM	1	8	4.41(1.64)	4.4 (1.64)	4.2 (1.7)	4.6 (1.6)		2.326**
***SEXHHED* (%)**								
Male (1)	265		80.30	80.3	80.8	80.0	0.029	
WRK-FRC	0	8	2.66 (1.38)	2.7 (1.60)	2.8 (1.4)	2.6 (1.4)		0.959
Institutional characteristics								
NTEXTNS	0	12	1.45 (2.64)	1.23 (2.14)	2.32 (2.87)	0.53(0.99)		-5.293***
CUTVHA	0.20	3.44	0.93 (0.53)	0.9 (0.50)	0.9 (0.5)	0.9 (0.5)		0.295
FARMEXP	2	50	22.23 (10.58)	22.2 (10.60)	21.1 (11.0)	23.0 (10.2)		1.553
DEXTNS	0.5	20	6.94 (3.54)	6.945(3.54)	4.840(3.40)	8.313(2.91)		-9.903***
AGROVET	1	25	15.97 (4.02)	16.0 (4.00)	14.7 (5.0)	16.8 (3.0)		4.754***
GROUP (%)								
Yes (1)	260		78.79	73.90	84.6	67.0	12.688***	
CREDIT								
Yes (1)	16		4.85	4.8	9.2	2.0	8.929*	

Figures in parentheses are standard deviations; *P<0.10; **P<0.05; ***P<0.01. Source: field survey data (2012).

The pattern of the gender distribution of household heads was similar among adopters and non-adopters. The Kenya's sex ratio stands at 97 males per 100 females (GoK, 2007). The study areas, therefore, have relatively lower proportion in respect of sex ratio compared to the national average.

The variable WRK- FRC (Workforce of a household) captured the effect of availability of family labour and the dependency ratio in the household. There was no significant difference between mean workforce of adopters (1.4) and non-adopters (1.4) of *Kilimo Salama* insurance scheme. Contact with government extension officer (NTEXTNS) informed on the effect of availability of extension services on adoption of innovative technology by farmers in crop production. On average, a smallholder farmer had about 1.45 days of extension contacts per year. There was a significant difference in contact with extension officers between adopters and non-adopters of *Kilimo Salama* insurance scheme at 1% level. It was also found that household head had an average of 22.2 years in farming with a minimum of 2 years and a maximum of 50 years.

Distance to the main market matters in the adoption of technology as well. The variable AGROVETwas used as a proxy of distance to the main market. The *Kilimo Salama* agrovets are situated in Nanyuki town which is the main market for the two divisions under consideration. The amount of inputs purchase, input and output price availability and other institutional services that the smallholder farmer can get might be determined by the distance of a smallholder farmer from the main towns and service centres. On average, to reach the nearest primary market household members had to travel 15.97 km with the minimum of 1 and a maximum of 25 km. There was a positive significant difference between

Table 3. Adoption and rate of adoption of *Kilimo Salama* insurance scheme.

Variable	Adoption coefficient	Extent of adoption coefficient	Average partial effects (APE)
AGROVET	-0.088 (0.027)***	-0.036(0.013)***	-0.013 (0.004)***
DEXTNS	-0.088 (0.032)***	0.031 (0.014)**	-0.001 (0.005)
LANDHA	0.015 (0.161)	0.127 (0.076)*	0.024 (0.021)
CREDIT	0.803 (0.161) *	0.066 (0.155)	0.071 (0.058)
FARMEXP	-0.020 (0.012)*	-0.007 (0.005)	-0.003 (0.002)*
GROUP	1.458 (0.467)***	0.417 (0.567)	0.181 (0.046)***
SEXHHED	-0.037 (0.269)	0.077 (0.130)	0.011 (0.043)
AGEHHED	-0.172 (0.101)*	0.028 (0.047)	-0.008 (0.011)
AGE ^{2}	0.002 (0.001)**	-0.002 (0.004)	0.000 (0.000)
EDUHHED	0.063 (0.026)**	-0.002 (0.015)	0.004 (0.004)
CUTVHA	-0.433 (0.244)*	0.064 (0.099)	-0.020 (0.037)
NUMBERHM	-0.126 (0.089)	0.040 (0.043)	-0.002 (0.011)
WRK_FRC	0.081 (0.104)	-0.075 (0.053)	-0.007 (0.016)
TENURE	-0.194 (0.159)	0.052 (0.056)	-0.005 (0.016)
NTEXTNS	0.243 (0.056)***	-0.009 (0.015)	0.016(0.005)***
PERCEP	0.894 (0.240)***		
OFF_FARM		-0.128 (0.107)	
CONS	4.401 (3.074)	-0.689 (1.575)	
OBSERVATIONS		330	
LOG LIKELIHOOD		-102.208	
WALD=CHI2(15)		81.75	
PROB>CHI^{2}		0.000	

Figures in parentheses are the standard errors; *P<0.10; **p< 0.05; ***p<0.01. Source: field survey data

adopters and non-adopters of *Kilimo Salama* insurance scheme at 1% level.

Farmers' membership to group plays a role in spreading information about an existing or emerging technology. Most of the farmers in the sample were found to be in groups (73.9%) with more adopters of the *Kilimo Salama* insurance scheme in groups (84.6%) compared to non-adopters (67.0%), and this difference was significant. Worthy noting is the fact that the effect of credit on adoption of the insurance scheme was not determined a priori. However, there was a positive significant difference in access to credit between adopters and non-adopters of *Kilimo Salama* insurance scheme at 10% level.

The double hurdle model results

The double hurdle model was estimated using STATA 10 econometric software (Burke, 2009). Diagnostic tests for the existence of multicollinearity and heteroskedasticity were conducted using Variance Inflation Factor (VIF) (Gujarati, 2004) and the White Test (White, 1980), respectively. The VIF results ranged between 1.09 and 1.67. Hence, multicollinearity was not a problem among the continuous variables. Similarly, for dummy variables the contingency coefficients test was employed. For the dummy variables, if the value of contingency coefficients is greater than 0.75, the variable is said to be collinear. The coefficients varied between 0.001 and 0.217, which indicated that there was no evidence of a strong correlation between the dummy variables. The White test for heteroskedasticity showed there was no problem of heteroskedasticity among the variables and the error term (p = 0.1980).

The maximum likelihood parameter estimates for the double hurdle model and the marginal effects of the variables were obtained using the Craggit command in Stata (Burke, 2009). In Table 3, the results of the determinants of adoption and extent of *Kilimo Salama* adoption are presented. Sixteen coefficients were estimated in the adoption hurdle where eleven of them were statistically significant. In the second hurdle only three coefficients were statistically significant.

The estimated coefficient AGROVET (distance to agrovet) variable was found to be negative (-0.088) and statistically significant at 1% level in adoption hurdle suggesting that farmers who are closer to the agrovet have a higher probability to adopt the insurance scheme than those that are far away. The probability marginal effects of the distance to agrovet variable were noted to be statistically significant at 1% level. This indicated that expected adoption of *Kilimo Salama* insurance scheme decreased by 1.3% as the distance to registered agrovet increased by one kilometre. The finding was in line with what was observed by Abdulai and Huffman (2005), who indicated that farmers living away from market incurred increased transaction costs and, therefore, they are unlikely to adopt a technology. Also, farmers, faced with high farm-to-market access costs or poor market access, commit less land, fertilizer and machinery resources to production (Obare et al., 2003). In the second hurdle, the rate of adoption, the coefficient for agrovet was negative and significant at 1% level suggesting that as distance to registered agrovet increased the amount of input bought decreased.

The coefficient for distance to extension agent (DEXTNS) was negative and significant at 1% level indicating that the greater distance to extension agent means lower the probability of adoption. In the second hurdle, the coefficient of distance to the extension was positive and significant at 5% level. The government subsidized fertilizer is distributed through the government extension agents and since *Kilimo Salama* insures chemicals, seeds and fertilizers, farmers who are far away from extension agent office may not access information when the subsidized fertilizer is available and, therefore decide to insure. The results were in contrast with the results reported by Adesina et al. (2000) who reported a significant positive relationship between access to extension services and the adoption decision of alley cropping in Cameroon.

The coefficient for LANDHA (farm size owned) by the household was not significant in adoption hurdle. This can be explained by the fact that adoption involves the use of inputs which are bundled in small amounts and; therefore adoption is not conditioned by the size of land. In the extent hurdle, the land size coefficient was positive and significant at 10% level. The implication is that household heads with large pieces of land bought a large amount of the inputs. This was in line with results of several studies (Goodwin, 1993; Goodwin and Mishra, 2006; Velandia et al., 2009) who found farm size positively related with the adoption of crop insurance. However, to the contrary, various authors did not find any significant relationship between farm size and demand of crop insurance (Smith and Baquet, 1996; Goodwin and Smith, 2003).

The coefficient for CREDIT (access to credit) by farmers positively and significantly influenced adoption at 10% level. This indicated that credit access was significant on farmer's adoption of *Kilimo Salama* insurance scheme. This could be because access to credit improves the financial situation of the farmer.

Consequently, it enables access to required resources if accessed at the beginning of the season. The results were congruent with the findings of Cai et al. (2009), Cole et al. (2009), Giné and Yang (2009) and Giné et al. (2008) who reported that credit received by farmers had a positive effect on the propensity of farmers to purchase insurance. The results were in contrast with results of Kakumanu et al. (2012) who stated that credit access does not have any significant effect on farmer's WTP for Weather-Based Crop Insurance Scheme.

The coefficient for FARMEXP (farming experience) was negative and significant at 10% level. Results suggest that as years in farming business by the household head increases the probability of adopting the *Kilimo Salama* insurance scheme decreased. Household who have been in farming business for a long time could have encountered weather-related risks and have ways of coping with them, hence not likely to adopt *Kilimo Salama* insurance scheme. However, one other possible explanation for the negative coefficient could be associated with imperfect knowledge of the technology. Some studies reported a decrease in adoption rate as farming experience increases (Foster and Rosenzweig, 1995; Ghadim and Pannell, 1999).

Group membership had a positive and significant influence on adoption (1% level). An explanation is that as household heads join groups they can get information about the existence of *Kilimo Salama* insurance scheme. The unconditional marginal effect of this coefficient was positive and significant at 1% level. This showed that adoption increased by 18.1% when farmer belonged to a group. These results were consistent with results reported by Nkamleu (2007) and Giné et al. (2008) who highlighted membership to a group as a key determinant on adoption of fertilizers in Cameroon and rainfall insurance in India respectively.

The estimates of the sex of household head, household size, workforce, and land tenure were not significant at all conventional levels contrary to the hypothesized positive influence on adoption of the insurance scheme. This could be because the insurance scheme insured maize which acts as a cash crop and food crop for the study area. Therefore, male and female headed households preferred its farming equally and there was no significant difference across households by gender of the household head. Also, the scheme insures inputs used in own or rented land therefore the land rights that could result to women not adopting new technology due to land inheritance could not apply.

The age of household head (AGEHHED) variable was negative and significant in the adoption decision at 10% level. This suggests that younger farmers had a high probability of adopting *Kilimo Salama* than older farmers. It could be that older farmers due to their high experience in farming and consequent awareness of risk and uncertainties, they have put in place risk management strategies and, therefore, do not consider *Kilimo Salama* as an effective risk management strategy. The results were consistent with findings of Kakumanu et al. (2012) who found out that, age had a negative and significant effect on farmer's willingness to pay (WTP) for Weather-Based Crop Insurance Scheme (WBCIS). Similarly, Sadati et al. (2010) and Velandia et al. (2009) reported that farmers' age influenced adoption of crop insurance negatively. However, a positive relationship between age and adoption of crop insurance was reported by Sherrick et al. (2004).

To capture the possibility of a non-linear relationship between age and adoption of *Kilimo Salama* insurance scheme the variable for AGE^2 (age of household head squared) was included in the model. Its coefficient was positive and significant at 5% level. This indicated that as the age of household head increased the probability of adoption increased at an increasing rate up to a certain age when adoption rate decreased. An explanation could be that as the household head gets aged, he/she had experience with production risks and accumulated some wealth which they can use when faced with production risks.

The coefficient for EDUHHED (education of household head) was positive and significant at 5% level. This showed that as years in education increased, adoption of *Kilimo Salama* also increased. Educated farmers are more aware of benefits of crop insurance scheme as compared to those who have less and, therefore, adopt the insurance scheme. The results are consistent with findings of the study by Sadati et al. (2010) which established a positive relationship between education of a household head and the decision to adopt crop insurance.

The coefficient for CUTVHA (cultivated land) was negative and significant at 10% in the adoption hurdle. An explanation is that because adoption of insurance scheme involves extra cost, the larger the size of land cultivated the lower the adoption rate due to the high cost of inputs. Furthermore, farmers wish to distribute risk by buying uninsured products which are cheaper as well as grow various enterprises which are not under insurance cover. Another explanation could be that farmers who cultivate larger areas have larger farms and are wealthy and can use other risk management strategies influencing insurance negatively.

The number of household members (NUMBERHM) was not significant in influencing adoption of the insurance as postulated. An explanation could be that large households size were categorised of young children who were dependants and could not provide labour on the farm. Further, the smaller households comprised older household's members who could provide little or no labour in their farm. The aged members depended on assistance from their off springs. Therefore, the size of the household did not have an effect on adoption and extent of adoption as anticipated.

Access to extension services by farmers positively influenced adoption of *Kilimo Salama* scheme at 1% level. The unconditional marginal effect on a number of contact with extension agent indicated that contact with extension agent increased adoption of *Kilimo Salama* insurance scheme by 0.5%. Contact with extension agents is one way of disseminating new technologies to farmers as a way of increasing agricultural productivity. Also, contact with extension services encourages adoption because exposure to information reduces subjective uncertainty about the insurance scheme. The finding of the study is consistent with the results obtained by Sadati et al. (2010) who reported a positive correlation between extension participation and adoption of crop insurance. Similarly, Kaliba et al. (2000) on maize adoption in Tanzania found that high intensity of extension services was among the major factors that positively influenced adoption of improved maize seeds. Further, Adesina and Baidu-Forson (1995) found a significant positive relationship between access to extension services and the adoption decision of new agricultural technology in Sierra Leone.

The estimated coefficient PERCEP (perception of *Kilimo Salama* insurance scheme) had a positive effect on adoption of *Kilimo Salama* insurance scheme at 1% level. Technology adoption is determined by many factors such as perceived characteristics of the technologies, farmer characteristics as well as institutional factors. The extent to which smallholder farmers perceives a technology such as *Kilimo Salama* insurance scheme as a risk mitigating strategy can determine adoption of the scheme. The adopter perception model reveals that the perceived aspects of innovations influence adoption behaviour (Adesina and Zinnah, 1993; Adesina and Baidu- Forson, 1995). Thus, adoption depends on users' judgement of the value to their technology.

CONCLUSION AND POLICY IMPLICATIONS

Based on the findings of the study, policies that promote access to agricultural technology information should be encouraged. The insurance scheme providers should add more effort in training farmers on benefits of an insurance scheme to compliment the information offered by the government extension services to enhance adoption. Also, membership in a group should be encouraged because group membership enhances information, knowledge sharing and access to credit at affordable interest rates to buy insured inputs.

Conflict of interests

The authors have not declared any conflict of interest

ACKNOWLEDGEMENTS

The authors acknowledge the support of African Economic Research Consortium (AERC) for the financial support. They also highly appreciate enumerators and the respondents for their cooperation.

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Vol.8(7), pp. 122-129, July 2016
DOI: 10.5897/JAERD2014.0651
Articles Number: 303A6B559132
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Correlates and determinants of climate change adaptation strategies of food crop farmers in Oke-Ogun area of South-western Nigeria

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Received 24 October, 2014; Accepted 21 April, 2015

Information on determinants of climate change adaptation strategies in Oke-ogun area, the food basket of South western Nigeria is scarce. Determinants of adaptation strategies to climate change among food crop farmers in Oke-Ogun area of Oyo State were therefore assessed. Multistage sampling procedure was used to select 160 food crop farmers, and data were collected through a well-structured interview schedule. Chi-square, Pearson Product Moment Correlation (PPMC), and Multiple Linear Regression were used in data analysis. Mono-cropping practices (χ^2 = 14.213), access to extension services (χ^2 = 6.201) and credit facilities (χ^2 = 8.077) had significant relationship with respondents' level of climate change adaptation strategies. Farm size (r = 0.232), level of awareness (r = 0.199), information exposure (r = 0.205) constraints to climate change adaptation strategies (r = -0.228) and perception (r = 0.319) also had significant relationship with level of adaptation strategies. Farm size (β = 0.259), perception of climate and effects (β = 0.257), constraints to adaptation to climate change effects (β = -0.118) were the three most important determinants of climate change adaptation strategies of food crop farmers. Agricultural extension activities should intensify awareness creation, while it also provides solutions to all climate change adaptation related constraints.

Key word: Perception, climate change, awareness, information exposure, constraints to adaptation.

INTRODUCTION

Agricultural production remains the main source of livelihood for most rural communities in developing countries and sub-Saharan Africa in particular. Here, agriculture provides a source of employment for more than 60% of the population and contributes about 30% of gross domestic product (Kandlinkar and Risbey, 2000). Rain-fed farming however dominates agricultural production in sub-Saharan Africa, covering around 97% of the total cropland and exposes agricultural production to high seasonal rainfall variability (Alvaro et al., 2009). Unfortunately, agriculture in the developing world according to Action Aid (2008) is particularly vulnerable to climate change. IPCC says that in some African countries, yield from rain-fed agriculture could be reduced upto 50% by the year 2020 (Intergovernmental Panel on Climate Change, IPCC, 2007).

Climate change adaptation aims to mitigate and develop appropriate coping measures to address the

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negative impacts of climate change on agriculture. In fact, one focus of adaptation strategies to climate change is targeted towards improving the wellbeing of the people. It is however worrisome that in spite of various adaptation strategies being pushed forward, food production level in the country is assuming an increasingly low trend in recent years, or at best, not matching the growing trend in the population. For example, the population of Nigeria is projected to increase by more than 50% by 2021 (Food and Agriculture organization, FAO, 2001).

During this 20 year period, the rural population is projected to increase by more than 25%, and the agricultural component is expected to grow by a slightly lower proportion, moderated by climate change and undercapitalization of the smallholder farmers. Therefore, it becomes imperative that appropriate adaptation measures be developed, with the aim of reducing the effects of climate change on food crop production.

Oke-Ogun, a region under the Saki Agricultural Zone of Oyo State Agricultural Development Programme (OYSADEP), consists of all the ten LGAs in Oke Ogun area of the state, and is known to produce the bulk of the food that is consumed both in and outside Oyo State. The region has about two-third of the total land area in Oyo State, suitable for the production of different food crops, including cassava, maize, yam, rice and cowpea. Others are vegetables, fruits, spices, among others.

Affirming this, Sangotegbe et al. (2012) asserted that Oke-ogun is the food basket of South-western Nigeria. However, recent food crisis in Oyo State and South western region of Nigeria suggests that climate change is already taking its toll on the activities of farmers as well as the production of major food crops for which the savannah region is renowned. Although, available statistics were not explicit about and affirmative of this, Sangotegbe et al. (2012) reported that majority of farmers in Oke-ogun area of south-western Nigeria perceived climate change to have unfavourable effects on food crop production activities and outputs. Developing appropriate adaptation measures will invariably reduce the negative impacts of climate change, and thereby contribute to improved productivity of the farmers and food security status of the south-west Nigerians. Identifying factors responsible for this low trend therefore becomes very imperative.

A number of factors have been linked with adaptation strategies to climate change of the people, and particularly of the farming population. Inter-governmental panel on Climate Change, IPCC, (2001) posited that poverty is directly related to vulnerability, and is therefore a rough indicator of the ability to cope and adapt. Corroborating IPCC, Lawrence et al. (2002) asserted that the poverty index is directly proportional to water availability, especially for farming communities. Even exploitation of water resources for economic gains is hindered by poverty. This therefore implies that the economic power of the people has a strong link with their adaptation strategies. Other factors such as awareness of new technologies (Maddison, 2007), perception of such technologies (Hassan and Nhemachena, 2008), inadequate technology adoption, education of farmers (Dinar et al., 2008), information and skills (Lee, 2007; Scheraga and Grambsch, 1998; United Nations Environment, Programme, UNEP, 2009), poor infrastructure (WDR, 1998; Mati, 2008), gender and religious issues (Spencer and White, 2007) and institutional constraints (Kelly and Adger, 1999) have equally been identified by different authors.

A number of authors have however disagreed on many of these factors, suggesting that it may not be an absolute rule that the factors apply for all places, as these may vary with ecological differences, among others. Ayanwuyi et al. (2010) reported that farm size was significantly and positively related to farmers' adaptation strategies in Ogbomosho Agricultural zone of Oyo State, while Nyangena (2007) posited that farmers with a small area of land are more likely to invest in soil conservation than those with a large area in Kenya.

On gender issues, FAO (2010) reports that male are often given greater priorities than female in terms of their access to credit facilities, land tenure system and training of farmers. On the other hand, Apata et al. (2009) establishes no significant relationship between sex and farmers' adaptation strategies to climate change in a similar study in western Nigeria. Clay, Reardon and Kangasniemi (1998) also reports a significant relationship between education and adoption decisions in a study in Rwanda, as against Ayanwuyi et al. (2010), which establishes no significant relationship between the two variables in another study with farmers in Ogbomoso Agricultural zone of Oyo State.

These divergent positions therefore are indications that factors affecting adaptation strategies to climate change may depend on several other externalities, an example of which is local peculiarities. Therefore, since there is a dearth of information on determinants of adaptation strategies to climate change among food crop farmers in Oke-Ogun area of Oyo State Nigeria; this study sets out to fill this gap.

The specific objectives of this study include to determine if significant relationship exists between food crop farmers adaptation strategies and their:

1. Socio-economic characteristics;
2. Preferred sources of information on climate change;
3. Awareness of food crop farmers on climate change
4. Perception of food crop farmers on effects of climate change on food crop production
5. Constraints faced by food crop farmers in adapting to climate change; and
6. Investigates the collective and individual contribution of each of these factors to farmers' adaptation strategies to climate change in the study area.

The following hypotheses were tested in pursuance of the specific objectives of the study:

Table 1. Sampling procedure for correlates and determinants of climate change adaptation strategies among food crop farmers Oke-Ogun Area of South-western Nigeria.

No. of LGAs Oke-Ogun	20% of LGAs	No. of wards	20% of wards	No. of communities/ wards	20% of community	No. of farmer in the communities	20% of farmer in the communities	Total no of farmers
10	Kajola	11	2	32	6	175	35	35
				30	6	210	42	42
	Saki west	10	2	30	6	200	40	40
				28	6	215	43	43
Total	2	21		120	36	800	160	160

Methodology adopted from Sangotegbe et al. (2012).

Ho1: There is no significant relationship between selected socio-economic characteristics of food crop farmers and their adaptation strategies.
Ho2: There is no significant relationship between food crop farmers preferred sources of information on climate change and their adaptation strategies
Ho3: There is no significant relationship between level of awareness of food crop farmers on climate change and their adaptation strategies.
Ho4: There is no significant relationship between the perception of food crop farmers on effects of climate change on food crop production and their adaptation strategies.
Ho5: There is no significant relationship between constraints faced by food crop farmers due to climate change and their adaptation strategies.
Ho6: There is no significant collective and individual contribution of each of these factors (independent variables) to farmers' adaptation strategies to climate change in the study area.

METHODOLOGY

Study area

The study was carried out in Oke-Ogun area of Oyo State which is located within the guinea savannah zone. It shares border with Kwara, Niger, Ogun and Osun States, as well as Niger Republic (a neighbouring country). The area is recognized as the 'food basket' of the Southwestern Nigeria, having an annual rainfall ranging between 700 to 1100 mm. The landmass of Oke-Ogun is about 13,537 km^2. This is about 60% of the total land mass of the present Oyo State. There are rivers and streams in most towns. Some of the rivers do not dry up even in the dry seasons. The land is good for large scale production of a wide variety of agricultural products. The people are Yorubas and the main economic activities include: farming, hunting, fishing, food processing, transportation and craft businesses. There is a limited level of infrastructural and institutional development in the study area.

Most farm families reside in the various settlements abounding in the villages and farmers still adopt traditional cultivation methods. The common food crops grown in the area include yam, cassava, maize, vegetables, melon, guinea corn, pawpaw, water melon, plantain, banana, and groundnut. Farmers still make use of traditional tools such as cutlass, hoe, axe, and so on. There are ten local government areas in the region. These include: Kajola, Iseyin, Itesiwaju, Iwajowa, Saki East, Saki West, Atisbo, Orelope, Irepo and Olorunsogo Local Government Areas, Oyo State. The notable towns in the Oke-Ogun
include Saki, Iseyin, Okeho, Kishi, Ago-Are, Tede, Ago-Amodu, Sepeteri, Ilero, Otu, Ado Awaye, Okaka, Ogboro and Igboho (Sangotegbe et al., 2012).

Multistage sampling procedure was used for this study. In the First stage, a simple random sampling technique was used to select 20% of a total of 10 Local Government Areas (LGAs), to make a total of 2 LGAs, which are Saki-West and Kajola Local Governments Areas. In the second stage, food crop farmers were purposively selected in the two LGAs. Two wards were selected in Stage 3 from each of the wards and 20% of each of the communities were selected across each ward in Stage 4. The list of the food crop farmers was then obtained from where 20% of food crop farmers was selected as the unit of analysis. This makes a total of 77 and 83 food crop farmers in Kajola and Saki West LGA, respectively. Therefore, a total of 160 food crop farmers were selected for the study (Table 1).

Methodology

Measurement of variables

The study measures socio-economic variables, sources of information, awareness of climate change and effects, perception of climate change and effects, constraints to climate change adaptation as well as the climate change adaptation strategies of food crop farmers in the study area. Respondents indicated their sex, marital status and level of education. Mono-cropping, access to credit facilities and access to extension services were assigned a score of 1 each, while 0 was assigned to otherwise (dummy). Respondents' age and farm size were measured in actual number of years, while farming experience was measured in hectares (Sangotegbe et al., 2012).

For respondents' level of exposure to information and adaptation strategies, a list of information sources (for exposure to information) and adaptation strategies (for level of adaptation strategies) were presented to the respondents from which they indicated frequency of use of each, as always (3) occasionally (2) rarely (1) and never (0). Sample items for each for these variables are presented below:

Sources of information

1. Radio.
2. Television.
3. Newspaper.

4. Magazines.
5. Extension Agents.
6. The internet.
7. Books.
8. Seminars.

Adaptation strategies

1. Cereal/legume intercropping.
2. Ridges across the slope.
3. Planting different crop varieties.
4. Use of organic fertilizers.
5. Fadama/irrigation.
6. Mixed farming.
7. Changing planting dates.
8. Soil protection through planting trees.
9. Planting different crops.
10. Zero tillage.

Awareness of climate change and effects was measured as Yes (1) and No (0), as response options to a list of items on the awareness scale. Sample items are presented below:

Awareness of climate change

1. I am aware the climate is changing
2. I know Climate change reduces quantity of food crop produced.
3. I am aware Climate change reduces quality of food crops.
4. I know the frequent drought is a result of climate change.
5. I am aware cropping calendar is varying due to climate change.
6. I know the atmosphere is getting hotter.

Perception of climate change and effects was measured as respondents indicated their level of agreements to a list of 28 negatively and positively worded perception statements. For positive statements, the order of scoring was strongly agree = 5, agree = 4, undecided = 3, disagree = 2 and strongly agree = 1. A reverse order applies for negative statements. Sample items are presented below:

Perception of climate change

1. Continuous rise in annual temperature reduces production of common food crops.
2. Yearly rains are not supporting food crop production as before.
3. Infestation of crops by pest is common due to climate change.
4. Climate change reduces working hours of food crop farmers.
5. There is a rapid loss of soil nutrients to erosion due to climate change.
6. Labour availability is being reduced due to climate change.
7. There is poor germination rate of food crops due to climate change.
8. Poor harvest of food crops cannot be due to climate change.

For constraints to climate change adaptation strategies, a list of constraints: Very severe = 3, severe = 2, not severe = 1 and not a constraint = 0, sample items are provided below.

Constraints to climate change adaptation strategies

1. Shortage of water.
2. Lack of credit facilities.
3. High cost of inputs.
4. Inadequate knowledge of adaptation strategies.
5. Inappropriate information on weather incidences.
6. Scarcity of improved seeds.
7. Inadequate access to fertilizers.

Index of each of these variables was obtained by summing up the score for each of the sources of information, adaptation strategies, awareness of climate change and effects, perception of climate change and effects and constraints to climate change adaptation. These scores were therefore obtained at interval levels and are used in the test of Hypotheses 2 to 5.

Level of adaption strategies was reduced to a lower level of measurement by categorizing respondents into two (high and low adapters), using the mean adaptation scores as the benchmark. This is necessary to appropriately determine relationship with the socio-economic variables measured at lower levels than the interval level in which the level of adaptation strategies had been originally represented.

For Objective 1, the relationship between sex, marital status, level of education, mono-cropping, inter cropping, access to extension contacts, access to credit facilities and the dependent variable (level of adaptation strategies) was analyzed using Chi-square. This is appropriate since the listed socioeconomic variables were measured at nominal levels. However, relationship between age, farming experience, farm size and level of adaptation strategies were determined using Pearson Product Moment Correlation (PPMC).

For Objectives 2 to 5, PPMC was used. Each of the objectives were operationalized as a Null Hypothesis 1, 2, 3, 4 and 5. All hypotheses were therefore tested at 5% level of significance. Multiple Linear regression was used to determine the key determinants of respondents' level of adaptation strategies in the study area. This is given as:

$$Y = a + \beta X_1 \ldots \beta_8 X_8$$

Where Y = Level of adaptation strategies (at interval level); X_1 = Exposure to information (at interval level); X_2 = Perception of climate change and effects (at interval level); X_3 = Constraints to climate change adaptation (at interval level); X_4 = constraints to climate change adaptation (at interval level); X_5 = awareness of climate change (at interval level); X_6 = Mono-cropping (Yes = 1; Otherwise = 0); X_7 = Access to credit facilities (Yes = 1; Otherwise = 0) and X_8 = extension contacts (Yes = 1; Otherwise = 0).

RESULTS AND DISCUSSION

The results of Ho1 (Table 2) shows that there is no significant relationship between the age of respondents and their adaptation strategies ($r=0.14$, $P>0.05$). This may be attributed to the fact that age may not be the key determinants of access to source of information which they need to adapt to change on their activities. This agrees with Ayanwuyi et al. (2010) and Apata et al. (2009) which reported no significant relationship between age and farmers adaptation strategies in part of Oyo State.

Farm size is however significantly related to the adaptation strategies of the farmers ($r=0.232$; $p<0.05$). The reason may be due to the fact that the respondents with larger farm size tend to take more proactive measures in order to reduce loss which could be greater

Table 2. PPMC table showing the relationship between age, farm size and adaptation strategies.

Variable	r-value	p-value	Remark	Decision
Age	0.140	0.077	NS	Accept Ho
Farm size	0.232	0.003	S	Reject Ho
Farming experience	0.070	0.377	NS	Accept Ho

Table 3. Chi-square analysis of relationship between respondents' sex, marital status, level of education, cropping system, access to credit facilities and access to extension contact.

Variable	χ^2	Df	p-value	Remark	Decision
Sex	1.381	1	0.240	NS	Accept Ho
Marital status	2.005	2	0.367	NS	Accept Ho
Level of education	2.132	3	0.545	NS	Accept Ho
Mono cropping system	14.213	1	0.000	S	Reject Ho
Intercropping system	0.830	1	0.362	NS	Accept Ho
Access to credit facilities	8.077	1	0.04	S	Reject Ho
Access to extension services	6.201	1	0.013	S	Reject Ho

than their counterparts with smaller farm size. This is also in agreement with Ayanwuyi et al. (2010), where it was found out that farm size was significantly related to farmers' adaptation strategies. It however negates that of Nyangena (2007) who posited that farmers with a small area of land are more likely to invest in soil conservation than those with a large area. There is no significant relationship between farming experience and farmers adaptation strategies ($r=0.070$; $p>0.05$). This may be attributed to the lack of relationship between age and level of adaptation strategies. It implies that farming experience is not important to adaptation strategies of respondents.

Table 3 is a presentation of chi-square analyses of relationship between respondents' sex, marital status, level of education, cropping system, access to credit facilities and access to extension contact. There is no significant relationship between respondents' sex and the adaptation strategies they employed. This negates the reports that male are often given greater priorities than female in terms of their access to credit facilities, land tenure system and training of farmers (FAO, 2001). It however agrees with Apata et al. (2009) which established no significant relationship between sex and farmers' adaptation strategies.

Marital status is also not significantly related to respondents adaptation strategies ($\chi^2=2.005$; $p>0.5$). The level of education has no significant relationship with adaptation strategies of the farmers. This agrees with Clay et al. (1998) who found that education was an insignificant determinant of adoption decisions. It however disagrees with Ayanwuyi et al. (2010), where they found the educational level of respondents to be significantly related to farmer adaptation strategies. The level of education may not be an important factor since agricultural extension services are available and provides information to farmers from different sources accessible by majority of the illiterate farmers.

Other sources of information were also being used for disseminating information across to the farmers, and this may be more important than formal education that may not really have direct bearing with formal education.

The cropping systems investigated by this study were mono-cropping and intercropping. There is a significant relationship between the practice and non-practice of mono-cropping system and the adaptation strategies ($\chi^2=14.213$; $p=<0.05$) of the respondents. The reason may be due to the desire to reduce the risk of loss that could be associated with mono-cropping system, and to compensate for the lack of cover crops which may help conserve moisture, especially, during the period of high temperature. However, intercropping system did not show any significant relationship with the adaptation strategies ($\chi^2=0.830$; $p=0.362$) of the farmers. The availability of cover crops which help to reduce water loss and nutrient loss to erosion and leaching may be one of the reasons.

Access to credit facilities and extension contacts by the respondents show a significant relationship with farmers' adaptation strategies to climate change at the respective χ^2 values of 8.077 and 6.201, with p-values of 0.04 and 0.013. These findings agree with Apata et al. (2009) which established a significant relationship between access to credit facilities and extension contacts with farmers' level of adaptation strategies.

Extension education was also found to be an important factor motivating increased intensity of use of specific soil and water conservation practices (Traoré et al., 1998; De

Table 4. PPMC analysis of the relationship between respondents awareness to climate change and adaptation strategies.

Variable	R	P	Remark	Decision
Awareness	0.199	0.012	S	Reject Ho
Information	0.205	0.009	S	Reject Ho
Constraints	-0.228	0.004	S	Reject Ho
Perception	0.319	0.000	S	Reject Ho

Harrera and Sain, 1999; Baidu-Forson, 1999; Bekele and Drake, 2003; Tizale, 2007).

Results of Ho2 *Relationship between respondents' non-socio-economic variables and climate change adaptation strategies in the study area*

Results of Ho2 (Table 4) also shows that there is a significant relationship between farmers sources of information and adaptation strategies to climate change (r=0.205; p<0.05). This result is in agreement with Kandlinkar and Risbey (2000) and Jones (2003) that the availability of better climate and agricultural information helps farmers make comparative decisions among alternative crop management practices and hence choose those that enable them cope better with changes in climate.

Awareness of the problem and potential benefits of taking action is another important determinant of adoption of agricultural technologies. Maddison (2007) found that farmers' awareness of changes in climate attributes (temperature and precipitation) is important for adaptation decision making. Several studies have found that farmers' awareness and perceptions of soil erosion problems positively and significantly affected their decisions to adopt soil conservation measures (Gould et al., 1989; Araya and Adjaye, 2001) associated with these changes.

The result of Ho3 (Table 4) shows that there is a significant relationship between respondents awareness and their adaptation strategies to climate change (r=0.199; p<0.05). The result is an indication that awareness is an important factor in the determination of climate change adaptation strategies farmers employ to improve food production. Hence, the more an individual is aware of climate change effects, the higher the likelihood of such to be proactive towards it.

The result of Ho4 (Table 4) shows a significant relationship between farmers' perception of climate change and their adaptation strategies (r=0.228; p<0.05). The implication is that farmers who unfavourably perceived effects of climate change will likely put up measures to adapt to these changes. It agrees with Hassan and Nhemachena (2008) that perception is an important factor influencing adoption.

Testing Ho5 (Table 4), the study also establishes that there is a significant relationship between food crop farmers' constraints to adaptation to climate change and their adaptation strategies (r=-0.228; p<0.05). The implication here is that farmers who are constrained one way or the other in their approaches to adapting to climate change effects are more unlikely to adapt as much as others who may be at an advantage. Kulukusuriya and Mendelsohn (2006) posited that lack of credit facilities and enabling environment for farmers will impede farmers' adaptive behaviours to climate change.

Results of Ho6: Key determinants of farmers adaptation strategies

Table 5 shows the contributions of various correlates of adaptation strategies of respondents. The result shows that on the over all, the covariates contribute about 26% of the adaptation strategies of the respondents, showing that the over-all contribution was significant at 5% level. The regression result (Table 3) goes further to show individual contribution of these correlates to the dependent variable. It reveals that of all the correlates, farm size (β=0.259) of respondents contributed highest to their adaptation strategies, followed by their perception of climate change and its effects (β=0.257). However, extension contacts (β=0.028) and access to credit facilities (β=0.043). This underlines the significance of the behavioural and economic factors in influencing adoption decisions and adaptive capacities of farmers.

Conclusion

It becomes imperative to conclude from the outcome of this study that since adaptation strategies to climate change can vary from place to place, factors affecting these strategies also vary. Based on the outcome of this study, owing to the low income status of the respondents, provision of credit facilities is an important tool for equipping food crop farmers against climate change effects. Also, the rural nature of the Oke-Ogun area of Oyo State, with many of the farmers having their farms located miles away from their homes, may have limited their access to extension services. However, the few respondents who have limited access to these services have benefited in terms of enhanced adaptive capacities

Table 5. Contribution of correlates to the level of climate change adaptation strategies of respondents.

Variable	Standardized co-efficient	T	P
Constants		2.804	.006
Information	0.135	1.746	.083
Perception	0.257	3.296	.001
Constraints	-0.188	-2.573	.011
Awareness	0.082	1.077	.283
Mono-cropping	0.189	2.579	.011
Access to credit facilities	0.043	0.555	.579
Access to extension contacts	0.028	0.365	.715
Farm size	0.259	3.620	.000

R^2 = 26.4% adjusted R^2 = 22.5%. $Y = a + 0.135X_1 + 0.257X_2 + 0.19X_3 + 0.082X_4 - 0.19X_5 - 0.04X_6 + 0.03X_7 + 0.259X_8$.

towards climate change effects on the production of food crops.

The study also concludes that food crop farmers' exposure to information, level of awareness to climate change as well as their perception of climate change and effects influenced their levels of adaptation strategies. This underlines and emphasizes the importance of information at effecting behavioural changes in people. It is however worthy of note that food crop farmers were being faced with different constraints which significantly reduced their adaptation strategies. The study finally concludes that both economic and behavioural factors interplay to determine the level of adaptation strategies, the food crop farmers in the area adopt against climate change effects. The following recommendations are therefore important:

1. Agricultural extension activities should place more emphasis on passing across information on adaptation strategies to climate change effects, and as a matter of fact, more extension agents should be recruited so as increase the number of food crop farmers covered in the process of disseminating agricultural innovation, and more importantly, climate change adaptation related information;.
2. Food crop farmers in Oke-Ogun area of Oyo State should form themselves into cooperative groups, so as to be able to access funds needed for adequate response to climate change effects.
3. Information on developing appropriate measures for climate change adaptation should be more intensified and more importantly, spread through different communication channels that can be easily accessed by the illiterate rural farmers. This is expected to induce behavioural change in the farmers, all things being equal.
4. Government should create enabling environments like provision of irrigation and credit facilities, as these will enhance the capacities of the rural poor farmers towards reducing the effects of climate change to the barest minimum.

Conflict of interest

The authors hereby declare that no conflict of interest exists among them.

ACKNOWLEDGEMENT

We acknowledge the funding support from the Department for International Development under the ACU/AAS Climate Impact Research Capacity and Leadership Enhancement Programme.

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Journal of Agricultural Extension and Rural Development