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Analysis of food crops farmers' choice of climate change adaptation strategies in Kwara State, Nigeria

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Abstract

Agriculture is one of the sectors most affected by ongoing climate change and as a result, farmers are using various adaptation strategies to cope with the impact of climate change in order to increase productivity. This study investigated the factors influencing the choice of a particular adaptation strategy by cassava and yam farmers in Kwara State, Nigeria. Primary data used for the study were obtained using a multi stage sampling technique. A structured questionnaire was administered to a sample of 150 randomly selected cassava and yam farmers in 12 villages in the study area. Descriptive statistics, a logit model, and the STATA computer program were used to analyze the data. The results showed that farmers have adopted diverse strategies such as changing planting dates, planting early maturing varieties and drought-tolerant varieties to deal with the impact of climate change. The results of the binary logit analysis showed that age of household head, household size, level of formal education, farm size, amount of rainfall, length of rainy season, awareness of climate change, member of farmers association, access to weather information, access to credit facilities, and number of strategies used, influenced the choice of at least two adaptation strategies. The study, therefore, recommended that government policies should be geared toward creating revenue-generating channels, strengthening the institutions that provide access to farm credit, making improved seed readily available, and providing extension services.

Introduction

Agriculture is the main source of livelihood for the majority of the populace in Nigeria, employing more than 60 percent of the population (Kadlinkaer & Risbey, 2000). Root and tuber crops are important in sub-Saharan Africa, especially in Nigeria, as they form a major part of the staple food consumed by the populace. In Africa, yam and cassava are important, not only as food crops but even more as major sources of income for rural households. Cassava and yam production in developing countries in sub-Saharan Africa such as Nigeria are highly vulnerable to variations in climatic parameters due to their dependence on rainfall.

Climate change and its effects on crop production is likely to change the existing agricultural systems, and has gained significant attention over the past years due to its detrimental effect on food security (IPCC, 2007; Srivastava, Gaiser, Paeth, & Ewert, 2012). The recently issued Assessment Report 5 of the Intergovernmental Panel on Climate Change (IPCC) states that negative impacts of climate trends have been more common than positive ones worldwide (IPCC, 2013), and there are between 5 and 200 million additional people at risk of hunger by 2100 (Palazzoli, Maskey, Uhlenbrook, Nana, & Bocchiola,

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2015; Olesen & Bindi, 2002). The impact of climate change under the A1B IPCC SERES scenario on yam production is significant and prominent particularly in the 2040s. During the period 2041–2050 it would decline significantly ranging from 18 to 33 percent based on the outcome of all three regional climate models considered (Srivastava et al., 2012).

The ongoing effects of climate change require the identification of appropriate adaptation strategies that aim to contain agricultural losses both in market goods and environmental services (De Salvo, Begalli, & Signorello, 2013, 2014). Adaptation is therefore critical and of necessity in developing countries, particularly in Nigeria where there is high vulnerability due to low adaptive capacity. Adaptation helps farmers to achieve food and security in the face of changing climatic conditions such as droughts and floods (Hassan & Nhemachena, 2008; Kandlinkaer & Risbey, 2000). Although African farmers have a low capacity to adapt to climate change, they have been able to survive and have coped in various ways over time (Hassan & Nhemachena, 2008). Studies have reported that access to credit facilities, awareness of climate change, use of improved varieties, soil conservation, changing planting dates, and irrigation are the most-used adaptation strategies in African countries (Bryan, Deressa, Gbetibouo, & Ringler, 2009; Komba & Muchapondwa, 2012; Mideksa, 2009). An understanding of factors that influence the choice of an adaptation strategy by farmers would help in designing incentives to enhance private adaptation. This study, therefore, seeks to examine how socio-economic, farm-specific, environmental, and institutional factors influence farmers' choice of adaptation strategies in Kwara State, Nigeria.

Materials and Methods

The study was conducted in Zone C of the Kwara State Agricultural Development Project (KWADP), Kwara State, which falls under the southern Guinea Savanna agro-ecological zone of Nigeria. The study area (Zone C) extends from latitude 8° 05' N to 9° 05' N and longitudes 4° 20' E to 5° 5' E, covering an area of about 4978 km^2.The area lies within a region described as having a tropical climate and is characterized by double rainfall maxima and a tropical wet and dry climate (Olanrewaju, 2003, 2009, 2010). The annual rainfall ranges from 1,000 mm to 1,500 mm with the rainy season beginning at about the end of March and lasting until early September, while the dry season begins in early October and ends in early March. Temperatures are uniformly high and range between 25°C and 30°C in the wet season throughout the season except in July–August when clouds prevent direct insolation, while in the dry season, they ranges between 33°C and 34°C. Relative humidity in the wet season is from 75 percent to 80 percent while in the dry season it is about 65 percent (NBS, 2009). The climate supports tall grass interspersed with short scattered trees, which predisposes the people to make farming their major occupation. Food crops produced are mostly maize, sorghum, yam, cassava, water yam, and sweet potato which constitute the main staple foods aside from cereals (Ajadi, Adeniyi, & Afolabi, 2011).

The cassava and yam farmers were selected using a multi stage sampling technique. Kwara State is divided into four agricultural zones (Zones A-D) by the KWADP. First, three out of the five Local Government Areas (LGAs) under Zone C in Kwara State were selected. The selection of the Asa, Moro and Ilorin East LGAs was based on the populations of cassava and yam farmers in the study area. Second, a random sampling technique was employed to select four communities each from the Asa, Moro and Ilorin East LGAs making a total of 12 communities. Lastly, 150 farming households (cassava and yam) were selected, and the head of each selected household was considered as the respondent. The main tool for data collection was a well-structured questionnaire. The questionnaire was formulated to collect information on farmers' awareness of climate change, adaptation strategies used by the farmers, and factors that influence their choice of an adaptation strategy.

The cassava and yam farmers were asked to score their usage of the various adaptation strategies and the frequency of use was indicated as none, once, twice, and several with scores of 1, 2, 3, and 4 respectively. The data were subjected to statistical analysis using frequency counts and percentages. A logit model was used to analyze the factors influencing the cıhoice of a particular adaptation strategy by farmers. The standard form of the logit model as specified by Greene (2003) and further exemplified by Tse (1987) is shown in equation (1):

$$\Pr(Y_i = 1) = \frac{e^{x_i\beta}}{1 + e^{x_i\beta}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

where Y_i is the random variable representing the adaptation strategy and χ_i is the vector of the explanatory variable that influences the choice of an adaptation strategy by the farmer.

The explicit form of the logit model is specified as shown in equation (2):

$$P_j = \beta_0 + \beta_1 SEX + \beta_2 AGE + \beta_3 EDU + \beta_4 SH + \beta_5 CCA + \beta_6 EXC + \beta_7 ACC + \beta_8 FME + \beta_9 FC + \beta_{10} FS + \beta_{11} DM + \beta_{12} AWI + \beta_{13} MFA + \beta_{14} RF + \beta_{15} TP + \beta_{16} LRSS + \beta_{17} DS + \beta_{18} NAU \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

where the independent variables used in the model are defined in Table 1, β (0, ..., 17) are parameters to be estimated, and P_j is the dependent variable which indicates the climate change adaptation strategy of the farmer under investigation. The dependent variables used in the model were: mulching, use of drought-tolerant varieties, changing planting date, multiple cropping, use of weather forecasts, planting early maturing varieties and higher yielding varieties. In each adaptation strategy, a separate logit model was estimated. A farmer choice of an adaptation strategy was indicated as 1 and otherwise as 0.

Table 1 Definition of independent variables used in the model

Variable	Definition	Measurement	*a priori* Expectation
SEX	Sex of the household head	1=male , 0= female	±
AGE	Age of the household head	years	±
EDU	Level of formal education	Years	+
SH	Size of household	Number of members	±
CCA	Climate change awareness	1= aware and 0= not aware	+
EXC	Extension contact	1=yes , 0= No	+
ACC	Access to credit	1=yes , 0= No	+
FME	Farming experience	Number of years	+
FC	Farm capital	Naira	+
FS	Farm size	Hectares	+
DM	Distance to market	Kilometers	±
AWI	Access to weather Information	1=yes and 0= No	+
MFA	Member of farmers association	1=yes and 0= No	±
RF	Rainfall	mm, 1= increase and 0=decrease	±
TP	Temperature	°C, 1= increase and 0=decrease	±
LRS	Length of rainy season	1= increase and 0=decrease	±
DS	Dry spells	1= increase and 0=decrease	±
NAU	Number of adaptation strategies used per famer	continuous	+

Results and Discussion

Descriptive Statistics of the Explanatory Variables

The summary statistics of the explanatory variables used in the logit model are presented in Table 2. The results showed that the mean age of the respondents was 48 years which indicates that the majority of the respondents were economically active. The average years of schooling of the respondents as estimated by this study was about 6.8 years indicating that majority had attended secondary schools or its equivalent, so that a large proportion of the sample had a primary understanding of climatic variables in relation to agricultural production. The average farm size was 2.15 hectares which showed that many of the respondents were small-scale farmers and that farm size is a critical factor influencing the output of farmers. This is in agreement with similar results obtained by Olayide (1990) who categorized small-scale farmers in Nigeria as having holdings ranging from 0.2 hectares to 9 hectares.

The results of the mean distribution of the various adaptation strategies used by the cassava and yam farmers (Table 3) indicate that multiple cropping (3.59), changing planting dates (3.37), and planting of drought-tolerant varieties (3.32) were the most commonly used adaptation strategies. The least adopted adaptation strategy was the use of weather forecasting (3.01). These results are in line with the results obtained by Sangotegbe, Odebode, and Onikoyi (2012) which revealed that the most commonly adopted adaptation measure to climate change by food crop farmers in the Oke-Ogun area of South Western Nigeria were: changing planting dates, mulching, planting different crops, and planting different crop varieties.

Table 2 Summary statistics of explanatory variables used in the model

Variable	Mean	Min	Max	SD
Sex	0.866	0	1	0.34
Age (years)	47.68	22	75	9.08
Level of education (years)	6.8	0	15	4.74
Size of household	7.22	2	15	2.67
Farming experience (years)	19.65	5	40	10.15
Farm capital (Naira)	84206.67	10000	500000	75476.41
Farm size (hectares)	2.15	0.3	10	1.27
Member of association	0.65	0	1	0.478
Extension contact	0.92	0	1	0 .27
Access to credit	0.47	0	1	0.5
Aware of climate change	0.91	0	1	0.28
Rainfall amount	0.51	0	1	0 .50
Dry spells	0.73	0	1	0.44
Length of rainy season	0.43	0	1	0.49
Access to weather information	0.59	0	1	0.49
Distance to market	15.92	0.3	64	17.49
Temperature	0.92	0	1	0.27
Number of strategies used	4.52	1	7	1.7

Table 3 Distribution of respondents according to their use of adaptation strategies

(n=150)

Adaptation Strategy	Never (%)	Once (%)	Twice (%)	Several (%)	Mean	Rank
Mulching	21.33	11.33	5.33	62.00	3.08	5th
Weather forecast	22.67	8.67	13.33	55.33	3.01	7th
Changing planting date	4.00	17.33	16.67	62.00	3.37	2nd
Planting of higher yielding variety	17.33	16.00	10.67	56.00	3.05	6th
Planting drought-tolerant variety	14.00	12.00	3.33	70.67	3.32	3rd
Planting early maturing variety	10.67	14.00	9.33	66.00	3.31	4th
Multiple cropping	6.67	7.33	6.00	80.00	3.59	1st

Source: Field survey (2015)

Factors Influencing Choice of an Adaptation Strategy by Cassava and Yam Farmers

The results of the binary logit model analysis which indicated the factors that influence the choice of adaptation strategies by the farmers are presented in Table 5. The results showed that most of the explanatory variables—age of the household head, household head level of education, farm size, amount of rainfall, length of rainy season, member of farmers association, access to weather information, access to credit facilities, and number of strategies used—affected the farmer's choice of an adaptation strategy in Zone C, Kwara State, Nigeria. The chi-squared results showed that the likelihood ratio statistics were highly significant ($p < .00001$) suggesting the model has strong explanatory power.

The age of the household head had a significant, negative effect on the choice of weather forecast and a positive effect on the choice of multiple cropping at the 10 percent and 5 percent levels, respectively (Table 4). A unit increase in the age of cassava and yam farmers would decrease adaptation of weather forecast by 0.0098 but increase the probability of choosing multiple cropping by 0.01134.

The effect of the household head level of formal education was significant on the choice of drought-tolerant varieties and early maturing varieties. An increase in the education level increased the effect of choosing early maturing crop varieties by 0.0299 (2.99%). Higher education gives farmers the ability to diversify income sources by engaging in other income-generating activities in addition to agriculture (Armah, Al-Hassan, Kuwornu, & Osei-Owusu, 2013). Household heads that are able to read and write have a higher probability of adopting an early planting strategy than those who cannot read or write.

Household size significantly influenced the choice of mulching, changing planting dates, and planting drought-tolerant varieties as adaptation strategies to climate change. This meant that larger food cropping families are able to choose these main climate change strategies better than smaller food cropping families. An increase in household size increases the effect of choosing mulching and changing planting dates as adaptation strategies by 0.02 and 0.04, respectively.

The choice of mulching, planting higher yielding varieties and early maturing varieties were significantly influenced by the size of farm. An increase in farm size increased the coefficient of selecting early maturing varieties by 0.091 and decreased the probability of choosing mulching by 0.081 (Table 6).

Group membership had a positive and significant influence on the choice of drought-tolerant varieties. Farmers who belonged to an association had a high probability of choosing drought-tolerant crop varieties by 0.30. Membership in groups exposed farmers to a wide range of ideas and sometimes gave farmers the opportunity to have better access to information, through training and extension services, which may have positively changed their attitude toward an innovation (Nkamleu, 2007).

Access to credit had a positive effect on the probability of choosing and using multiple crop varieties and mulching but a negative effect on the choice of drought-tolerant varieties. This implies that an additional unit of credit for a food cropping household would increase the probability of choosing and using multiple crop varieties and mulching by 0.236 and 0.1916, respectively.

Conclusion

The study used a logit model to investigate the various adaptation strategies used by cassava and yam farmers and the factors influencing these farmers' decision to choose an adaptation strategy to combat climate change. Famers have applied various adaptation techniques such as changing planting dates and planting early maturing varieties and drought-tolerant varieties to deal with the impact of climate change. The results indicated that most of the variables used in the model significantly influenced the choice of a technique. These consisted of: age of household head, household size, level of formal education, farm size, amount of rainfall, length of rainy season awareness of climate change, member of farmers association, access to weather information, access to credit facilities, and number of strategies used.

Conflict of Interest

There is no conflict of interest.

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Table 4 Parameter estimates of the logit model of climate change adaptation strategies

Explanatory Variable	Mulching	Weather forecast	Changing planting date	Planting higher yielding variety	Planting drought-tolerant variety	Planting early maturing variety	Multiple cropping
Sex	-1.5774 (1.1155)	-0.5085591 (0.700979)	1.056721 (0.7204086)	-1.157035 (0.8319531)	0.1855276 (0.6852533)	1.436027 (0.7439664)**	-1.843528 (2.136009)
Age of household head	-0.02922 (0.05129)	-0.065643 (0.03827)*	-0.0827797 (0.0394992)	-0.0246873 (0.0467197)	0.0184859 (0.0401113)	0.0639673 (0.0397189)	0.2028894 (0.0890066)**
Level of formal education	0.07629 (0.8447)	-0.0011041 (0.0544782)	-0.0830038 0.052945	-0.1087236 (0.0722132)	-0.1159352 (0.0598317)**	0.2516106 (0.0694078)**	0.1305403 (0.1146425)
Household size	0.3038 (0.15127)**	-0.1370312 (0.0956527)	0.2538312 (0.111099)**	-0.021298 (0.1193835)	-0.1698199 (0.0991952)*	-0.0650912 (0.1142836)	0.1147412 (0.1715414)
Farming experience	0.06754 (0.05236)	0.051768 (0.0347633)	0.0292353 (0.0332634)	0.0065421 (0.0398592)	-0.0558921 (0.0351644)	-0.0575887 (0.038837)	-0.0270627 (0.0655454)
Distance to market	-0.0663638 (0.040336)	0.0327318 (0.0214984)	-0.0255726 (0.0209906)	0.0310381 (0.0264343)	0.0163315 (0.0245825)	0.0118124 (0.0257495)	0.054242 (0.0404341)
Farm capital	0.0000247 (0.000011)**	6.29e-06 (5.75e-06)	(4.46e-06) (4.61e-06)	(-2.89e-06) (5.92e-06)	1.52e-06 (5.44e-06)	-4.83e-06 (6.50e-06)	7.98e-06 (0.0000148)
Farm Size	-1.2353 (0.51779)**	-0.3127271 (0.3040307)	-0.180203 (0.2772627)	0.0074454 (0.3237872)**	0.256029 (0.3230613)	0.771293 (0.3517027)**	-0.6460058 (0.6333833)
Access to credit facilities	2.707417 (1.3166)**	1.08868 (0.6680403)	0.2924898 (0.6178093)	0.7634987 (0.7638545)	-2.544808 (0.8421091)**	-.5675811 (0.7824572)	4.223884 (1.576475)**
Access to weather information	0.3428384 (1.01215)	0.0329348 (0.6404926)	-2.167521 (0.7734825)**	-0.0536639 (0.8507874)	0.0959432 (0.6958813)	0.8440577 (0.7514853)	3.355636 (1.644609)**
Member of farmers association	0.9803101 (1.24888)	-0.2459951 (0.7325047)	-1.426882 (0.7240576)**	-0.5511743 (0.8829287)	2.196159 (0.9377898)**	-.0522765 (0.8793066)	1.173899 (1.788377)
Extension contact	-4.167189 (2.4269)*	0.7620332 (0.9547858)	-0.1623433 (1.213425)	-0.4394316 (1.165857)	0.3115784 (0.9574749)	.1434122 (1.075627)	-1.297087 (2.233272)
Aware of climate change	-3.1708 (1.91716)*	1.149723 (0.9673889)	-0.3783761 1.049893	0.9470139 (1.122769)	1.210896 (0.9796499)	-2.753516 (1.312522)**	-4.438031 (2.283535)**
Rainfall amount	0.06317 (0.86717)	-0.1684331 (0.5638689)	0.2395374 (0.5541837)	-1.903036 (0.8278107)**	0.2039983 (0.5996576)	0.9217703 (0.6198697)	3.17078 (1.313135)**
Temperature	-3.429 (1.6605)**	-0.8239569 (0.940651)	0.4539326 (0.8732471)	1.537689 (1.119435)	0.5909044 (0.9128229)	0.8294806 (1.017379)	-1.467548 (1.81532)
Length of rainy season	0.3853 (1.0253)	0.1726924 (0.6385454)	0.8326267 (0.6683585)	2.741196 (0.9153651)**	-0.7631825 (0.6480356)	-0.6374714 (0.7038443)	-3.613431 (1.56384)**
Dry spell	-1.1205 (0.9266)	0.0753559 (0.5330265)	0.6270913 (0.5324158)	-0.4470928 (0.6429519)	-0.0622132 (0.5952625)	-0.2789823 (0.622)	-1.360486 (1.029126)
Number of adaptations used	2.688667 (0.5444)**	1.048855 (0.19827)**	0.6979355 (0.160574)**	1.618098 (0.3028561)**	0.7465543 (0.1731855)**	1.240504 (0.2393244)**	3.259036 (0.8343992)**
Constant	-1.256125 (3.503435)	-2.586324 (2.199771)	0.4900082 (2.071007)	-5.943486 (2.719235)**	-2.807986 (2.192462)	-8.629363 (2.659346)	-15.66351 (5.993337)**
Number of observations	150	150	150	150	150	150	150
LR chi-square(18)	130.98	69.10	63.82	102.46	54.47	80.44	97.06
Prob > chi-square	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R^2	0.6575	0.3350	0.3203	0.4979	0.3001	0.4183	0.6466
Log likelihood	-34.119537	-68.569271	-67.69977	-51.657088	-63.530266	-55.93444	-26.528437

Note: Figures in parentheses are the robust standard errors, * and ** represent significance at 10 percent and 5 percent, repsectively

Source: Field data analysis (2015)

Table 5 Marginal Effects (dy/dx) from the logit model of climate change adaptation strategies

Explanatory Variable	Mulching	Weather forecast	Changing planting date	Planting higher yielding variety	Planting drought-tolerant variety	Planting early maturing variety	Multiple cropping
Sex	-.1116375 (0.07638)	-0.0764797 (0.104809)	0.1556274 (0.1032925)	-0.126863 (0.0893988)	0.0253807 (0.0936565)	0.1708959 (0.0848738)	-0.1030717 (0.1178982)
Age of household head	-0.0020682 (0.003608)	-0.0098717 (0.0055562)	-0.0121913 (0.0055557)**	-0.0027068 (0.0051011)	0.0025289 (0.0054745)	0.0076125 (0.0045797)*	0.0113436 (0.0044663)**
Level of formal education	0.005399 (0.005906)	-0.000166 (0.0081925)	-0.0122243 (0.0075804)	-0.011921 0.0076856)	-0.0158603 (0.0077666)**	0.0299432 (0.006661)**	0.0072985 (0.0062587)
Household size	0.0215023 (0.0099)**	-0.0206075 (0.0140233)	0.0373827 (0.0154852)**	-0.0023352 (0.0130825)	-0.0232319 (0.0130839)*	-0.0077462 (0.0135485)	0.0064152 (0.0094726)
Farming experience	0.0047802 (0.003637)	0.0077851 (0.005101)	0.0043056 (0.0048578)	0.0007173 (0.0043692)	-0.0076462 (0.0046685)	-0.0068534 (0.0044994)	-0.0015131 (0.0036611)
Distance to market	-0.0046967 (0.00276)*	0.0049224 (0.0031458)	-0.0037662 (0.0030369)	0.0034032 (0.0028465)	0.0022342 (0.0033505)	0.0014058 (0.0030584)	0.0030327 (0.0021728)
Farm capital	1.75e-06 (7.08e-07)**	9.46e-07 (8.53e-07)	6.58e-07 (6.71e-07)	-3.17e-07 (6.46e-07)	2.08e-07 (7.44e-07)	-5.75e-07 (7.67e-07)	4.46e-07 (8.26e-07)
Farm size	-0.0874302 (0.032707)**	-0.0470295 (0.0451419)	-0.0265392 (0.0406393)	0.0008163 (0.035501)	0.0350255 (0.0438183)	0.0917886 (0.039249)**	-0.0361182 (0.0347121)
Access to credit facilities	0.1916112 (0.08805)**	0.1637213 (0.0978475)	0.0430761 0.0907542	0.0837137 (0.0830272)	-0.3481374 (0.1033403)**	-0.0675456 (0.0923217)	0.2361575 (0.0733729)**
Access to weather information	0.0242636 (0.071442)	0.0049529 (0.0963174)**	-0.3192192 (0.1039634)**	-0.005884 0.0933076)	0.0131253 (0.0951844)**	0.100448 (0.0883028)	0.1876137 (0.0837821)**
Member of farmers association	0.0693792 (0.08683)	-0.036994 (0.1100291)	-0.2101424 (0.1014664)**	-0.0604335 (0.0965845)	0.3004412 (0.120778)	-0.0062212 (0.1046443)	0.0656327 (0.0989782)
Extension contact	-0.2949232 (0.163768)*	0.1145985 (0.1423078)	-0.0239089 (0.1786585)	-0.0481814 (0.1274606)	0.0426249 (0.1308081)	0.0170669 (0.128041)	-0.0725202 (0.1236952)
Aware of climate change	-0.2244063 (0.12970)*	0.1729013 (0.1429739)	-0.0557249 (0.1542983)	0.1038352 (0.1223756)	0.1656542 (0.1312532)	-0.3276851 (0.1487374)*	-0.2481304 (0.1169871)**
Rainfall amount	0.0044712 (0.061399)	-0.0253298 (0.0847014)	0.0352776 (0.0814052)	-0.2086582 (0.0848202)**	0.0279076 (0.0819132)	0.1096963 (0.0715879)	0.1772784 (0.0621453)**
Temperature	-0.2427168 (0.10862)**	0.0259704 (0.0959207)	0.0668524 (0.1282108)	0.1685997 (0.1196552)**	0.0808375 (0.1244275)	0.0987132 (0.1196532)	-0.0820507 (0.0999703)
Length of rainy season	0.027269 (0.07238)	-0.1239109 (0.1401834)	0.1226241 (0.096672)	0.3005582 (0.088356)	-0.1044057 (0.0868923)	-0.075863 (0.0827494)	-0.202027 (0.0746772)**
Dry spell	-0.0792993 (0.063518)	0.0113324 (0.0801198)	0.0923542 (0.0771653)	-0.0490214 (0.0701794)	-0.0085109 (0.0814019)	-0.0332006 (0.0738739)	-0.0760648 (0.0557645)
Number of adaptations used	0.1902842 (0.01785)**	0.1577323 (0.0179648)**	0.1027876 (0.0177306)**	0.1774161 (0.017498)**	0.1021309 (0.0178465)**	0.1476275 (0.0172086)**	0.1822128 (0.0270677)**

Note: Figures in parentheses are the robust standard errors, * and ** represent significance at 10 percent and 5 percent, respectively

Source: Field data analysis (2015)

References

Ajadi, B. S., Adeniyi A., & Afolabi, M. T. (2011). Impact of climate on urban agriculture: Case study of Ilorin City, Nigeria. *Global Journal of Human Social Science, 11*(1), 234–254.

Armah, R. N. A., Al-Hassan, R. M., Kuwornu, J. K. M., & Osei-Owusu, Y. (2013). What influences farmers' choice of indigenous adaptation strategies for agrobiodiversity loss in Northern Ghana? *British Journal of Applied Science & Technology*, *3*(4), 1162–1176.

Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: Options and constraints. *Environmental Science and Policy*, *12*, 413–426.

De Salvo, M. D., Begalli, D., & Signorello, G. (2013). Measuring the effect of climate change on agriculture: A literature review of analytical models. *Journal of Development and Agricultural Economics. 5*(12), 499–509. doi:10.5897/JDAE2013.0519.

De Salvo, M. D., Begalli1, D., & Signorello, G. (2014). The Ricardian analysis twenty years after the original model: Evolution, unresolved issues and empirical problems. *Journal of Development and Agricultural Economics, 6*(3), 124–131. doi: 10.5897/JDAE2013.0534.

Greene, W. H. (2003). *Econometric Analysis* (5th ed.). Upper Saddle River, NJ: Prentice Hall.

Hassan, R., & Nhemachena, C. (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal of Agricultural and Resource Economics, 2*, 83–104.

IPCC. (2007). *Climate Change 2007: Impact, Adaptation and Vulnerability.* Intergovernmental Panel on Climate Change Working Group II. Retrieved from http://www.ipcc.ch

IPCC. (2013). Summary for policymakers. In T. F. Stocker, D. Qin, G. K. Plattner, M. Tignor, S. K. Allen, J. Boschung, et al. (Eds.), *Climate Change 2013: The Physical Science Basis.* Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY: Cambridge University Press.

Kandlinkaer, M., & Risbey, J. (2000). Agricultural impacts of climate change: If adaptation is the answer, what is the question? *Climatic Change, 45*, 529–39.

Komba, C., & Muchapondwa, E. (2012). *Adaptation to climate change by smallholder farmers in Tanzania.* Economic research Southern Africa (ERSA) working paper 299. Retrieved from http://econrsa.org/home/index.php

Mideksa, T. K. (2009). Economic and distributional impacts of climate change: The case of Ethiopia. *Global Environmental Change, 20*, 278–286.

National Bureau of Statistics (NBS). (2009). *NBS/CADP Baseline Survey Report*. Commercial agriculture development project (CADP).

Nkamleu, G. B. (2007). Modelling farmers' decisions on integrated soil nutrient management in Sub-Saharan Africa: A multinomial logit analysis in Cameroon. In A. Bationo (Ed.), *Advances in Integrated Soil Fertility Management in Sub-Saharan Africa: Challenges and Opportunities* (pp. 891–903). Berlin, Germany: Springer Publishers.

Olanrewaju, R. M. (2003). The preliminary study of climate variable on the growth of melon in Kwara State. *Journal of the Nigerian Meteorological Society, 5*(1), 1–7.

Olanrewaju, R. M. (2009). Effect of climate on yam production in Kwara State, Nigeria. *Environmental Issues, 3*(1), 5–9.

Olanrewaju, R. M. (2010). Climate and rice production in a part of Niger River Basin Development Authority Area (NRBDA). A case study of Edu and Lafiagi Local Government areas of Kwara State, Nigeria. *Journal of Meteorology and Climate Science, 8*(2), 102–110.

Olayide, S. O. (1990). Characteristics problems and significance of farmers. In S. O. Olayide , J. A. Eweka, & V. E. Bello Osagie (Eds.), *Nigeria small farmers' problems and prospects in integrated rural development.*

Olesen, J. E., & Bindi, M. (2002). Consequences of climate change for European agricultural productivity, land use and policy. *European Journal of Agronomy, 16*, 239–262.

Palazzoli , I., Maskey, S., Uhlenbrook, S., Nana, E., & Bocchiola, D. (2015). Impact of prospective climate change on water resources and crop yields in the Indrawati basin, Nepal. *Journal of Agricultural Systems, 133*, 143–157.

Sangotegbe, N. S., Odebode, S. O., & Onikoyi, M. P. (2012). Adaptation strategies to climate change by food crop farmers in Oke-Ogun area of South Western Nigeria. *Journal of Agricultural Extension, 16*(1), 119–131. doi:10.4314/jae.v16i1.12

Srivastava, A. K., Gaiser, T., Paeth, H., & Ewert, F. (2012). The impact of climate change on Yam (*Dioscorea alata*) yield in the savanna zone of West Africa. *Agriculture, Ecosystems and Environment, 153*, 57–64.

Tse, Y. K. (1987). A diagnostic test for the multinomial logit model. *Journal of Business and Economic Statistics, 5*(2), 283–286.