Nota técnica (inglés)

What Drives Crop Farmers' Adaptation to Climate Change? Evidence from Smallholder Farmers in Kogi Agricultural Zones, Nigeria

¿Qué impulsa la adaptación de los agricultores al cambio climático? Evidencia de pequeños agricultores en las zonas agrícolas de Kogi, Nigeria

Stephen Jimoh Ibitoye[1]
Ufedo Monday Shaibu[2]
Emmanuel Odunayo Omojola[3]
Stella O. Adejoh[4]

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[1] Kogi State University Anyigba, Nigeria. Professor of Production Economics and Farm Management at the Department of Agricultural Economics and Extension, Kogi State University Anyigba.
[2] Kogi State University Anyigba, Nigeria. Lecturer at the Department of Agricultural Economics and Extension, Kogi State University Anyigba
[3] Ekiti State University, Ado-Ekiti, Nigeria. PhD student in Environmental Management at the Ekiti State University, Ado-Ekiti, Nigeria.
[4] Kogi State Bureau of Public Procurement (KGBPP), Nigeria.

Resumen

Escenarios predominantes en las zonas agrícolas Kogi de Nigeria, tales como; el ambiente se vuelve más cálido y seco, las estaciones lluviosas se vuelven impredecibles y cada vez más erráticas y las diferentes variaciones son una clara evidencia del cambio climático que alterna la fecha o la duración del cultivo, y se ha convertido en una preocupación importante para la producción agrícola sostenible. Este estudio determinó los factores que impulsan la adaptación de los agricultores de cultivos al cambio climático en las Zonas Agrícolas de Kogi, Nigeria, utilizando a ciento cincuenta (150) agricultores seleccionados al azar como encuestados. Los datos primarios relevantes obtenidos mediante la administración del cuestionario en marzo - junio de 2018 se analizaron utilizando herramientas estadísticas descriptivas e inferenciales. El modelo de regresión de Tobit se utilizó para determinar los impulsores de la adaptación al cambio climático. Las características socioeconómicas de los encuestados de la muestra mostraron que el 78,67% eran hombres con una edad media de 40 años. El resultado mostró además que la mayoría de los agricultores eran conscientes del efecto del cambio climático (puntaje sigma = 5.714) con respecto a los siguientes elementos: ambiente cálido (puntaje sigma = 5.300), lluvia irregular (puntaje sigma = 5.300) y rendimiento reducción (puntuación sigma = 5.082). El resultado de la regresión de Tobit indicó que la edad (ß= 0.028), el tamaño del hogar (ß = -0.072), la pertenencia a la sociedad cooperativa (ß = 0.439) y el número de contactos de extensión (ß = 0.026) fueron factores importantes que impulsaron a los pequeños agricultores. adaptación al cambio climático. Para decisiones políticas informadas; El gobierno y otras partes interesadas relevantes deberían alentar a los agricultores a unirse a las sociedades cooperativas agrícolas y también continuar apoyando el sistema de prestación de servicios de extensión para aumentar las capacidades de adaptación de los agricultores.

Palabras clave: cambio climático, adaptación, extensión, sociedad cooperativa

Abstract

Prevailing scenarios in Kogi agricultural zones of Nigeria, such as; the environment becoming hotter and drier, rainy seasons getting unpredictable and increasingly erratic and different variations are clear evidence of climate change which alternate cropping date or duration, and has grown to become a major concern for sustainable agricultural production. This study determined factors that drive crop farmers' adaptation to climate change in Kogi Agricultural Zones, Nigeria using a multistage random sampling technique selected total of one hundred and fifty (150) farmers as respondents. Relevant primary data obtained through questionnaire administration in March – June, 2018 were analyzed using descriptive and inferential statistical tools. The Tobit regression model was used to determine the drivers of adaptation to climate change. The socioeconomic characteristics of the sampled respondents showed that 78.67% were males with a mean age of 40 years. The result further showed that majority of the farmers were aware of the effect of climate change (sigma score = 5.714) with respect to the following items: hot environment (sigma score = 5.300), irregular rainfall (sigma score = 5.300), and yield reduction (sigma score = 5.082). The Tobit regression result indicated that age (ß= 0.028), household size (ß = -0.072), membership of cooperative society (ß = 0.439) and number of extension contacts (ß= 0.026) were significant factors that drive smallholder crop farmers' adaptation to climate change. For informed policy decisions; government and other relevant stakeholders should encourage farmers to join agricultural cooperative societies and also continue to support the extension service delivery system to increase farmers' adaptation capacities.

Key words: Climate Change, Adaptation, Extension, Cooperative Society.

Introduction

Prevailing scenarios in Kogi agricultural zones of Nigeria, such as; the environment becoming hotter and drier, rainy seasons are getting unpredictable and increasingly erratic and different variations are clear evidence of climate change which has grown to become a major concern for sustainable agricultural production (Shaibu et al. 2020). Hence, the need for appropriate prevention and adaptation measures to climatic variables. No doubt, the negative impacts of climate change can be reduced through adaptation by farmers taking adaptive actions or through governments' actions and inactions aimed at promoting appropriate and effective adaptation measures (Fussel et al., 2006).

Prior to the emergence of global pandemic (novel COVID – 19), issues of climate change have been on the front burner of society's environmental discourse in most parts of the world. In most studies, rural farmers' level of awareness seems to be on increase regarding their experiences in change and length of seasons, incidence of environmental hazards such as flood, droughts, and crop failures, long term shift in wind speed, change in rainfall intensity and uncertainty of rain (Shaibu et al., 2016 and Smarden, 2011). The level of farmers' awareness differs by experience and of interest in resource use. Coping with natural climate change has always been a challenge, especially in the study area where the farming population is characterized with low education (Shaibu, et al., 2020) and the climatic conditions are unpredictable.

Udenyi (2010) reported that climate change and severe weather events often impede sustainable farming development, especially in developing countries (Nigeria inclusive) where agriculture is rain fed and where external shock such as poverty, poor access to inputs and credit are common. This is the context in which crop farmers in the study area carry out their farming and other livelihood activities. Although several studies have been carried out on adaptation to climate change in developing countries (Badi, 2010; Nhemachena and Hassan 2007; Selvaraju, et al. 2006); these studies do not look at the determinants of adaptation to climate change with respect to the study area (Kogi State, Nigeria).

Furthermore, sequel to the effect of climate change, agricultural production methods in Kogi State and Nigeria at large have not performed optimally despite many years of efforts on technology generation and transfer. This situation has implications on farmers' productivity. Previous researchers made several attempts in assessing the determinants of farmers' adaptation to climate change (for example; Apata, et al. 2009; Deressa, et al. 2010; Franncis and Theophilus, 2011; Idrisa, et al. 2012). Findings from these studies showed various positions as regard adaptation to climate change and its determinants. Empirical investigations are likely to have peculiar socioeconomic and cultural difference that may limit the blanket application of research findings, Hence, the need for independent studies of specific locations (Asrat and Simane, 2018). To the best of the knowledge of this investigation, existing research on determinants of farmers' adaptation to climate change were done outside the scope of this study. This study assessed the factors that drive Kogi State crop farmers' adaptation to climate change. This is the research gap that the study intends to fill. Filling such a gap will provide empirical facts for evidence-based policy recommendations.

Objectives of the Study

The specific objectives of this study are to:

1. describe the socioeconomic characteristics of crop farmers in the study area;
2. assess crop farmers awareness on the effect of climate change; and
3. determine the factors that influence adaptation to climate change by crop farmers.

Methodology

The study area was Kogi State, Nigeria. The state has 21 Local Government Areas with Lokoja as the capital. It is located between Longitudes 5o, 22'E to 7o 49'E and Latitude 6o 33'N to 8o 44'N. It occupies 29,833 square kilometers with a population of 3,314,043 according to 2006 Census figures (which is the last and most recent official census) and a projected population of 4,473,500 in 2016. Agriculture is the mainstay of the economy with over 70 percent of the population depending on agriculture and agricultural related activities as means of livelihood. The state has suitable ecological and climatic conditions which make it possible to produce various agricultural products (Adejoh et al. 2016). Some of the farm produce include among others; coffee, cocoa, palm oil, cashew, peanuts, soya beans, cocoyam, maize, cassava, yam, rice and melon.

Kogi state is made up of four agricultural zones. These zones and their headquarters include; Zone A: Ayetoro Gbede, Zone B: Anyigba, Zonc C: Koton-Karfe and Zone D: Alloma. For political purposes, the state is divided into three senatorial districts such as; the eastern senatorial district which is comprised of Igala ethnic group, the Central senatorial district that is made up of the Ebira ethnic group and the Western senatorial district which is made of the Yoruba ethnic group. The state is bounded to the west by River Niger and Niger state, in the east by Enugu state, in the south by Anambra state and in the north by Federal Capital Territory, Benue and Nassarawa states.

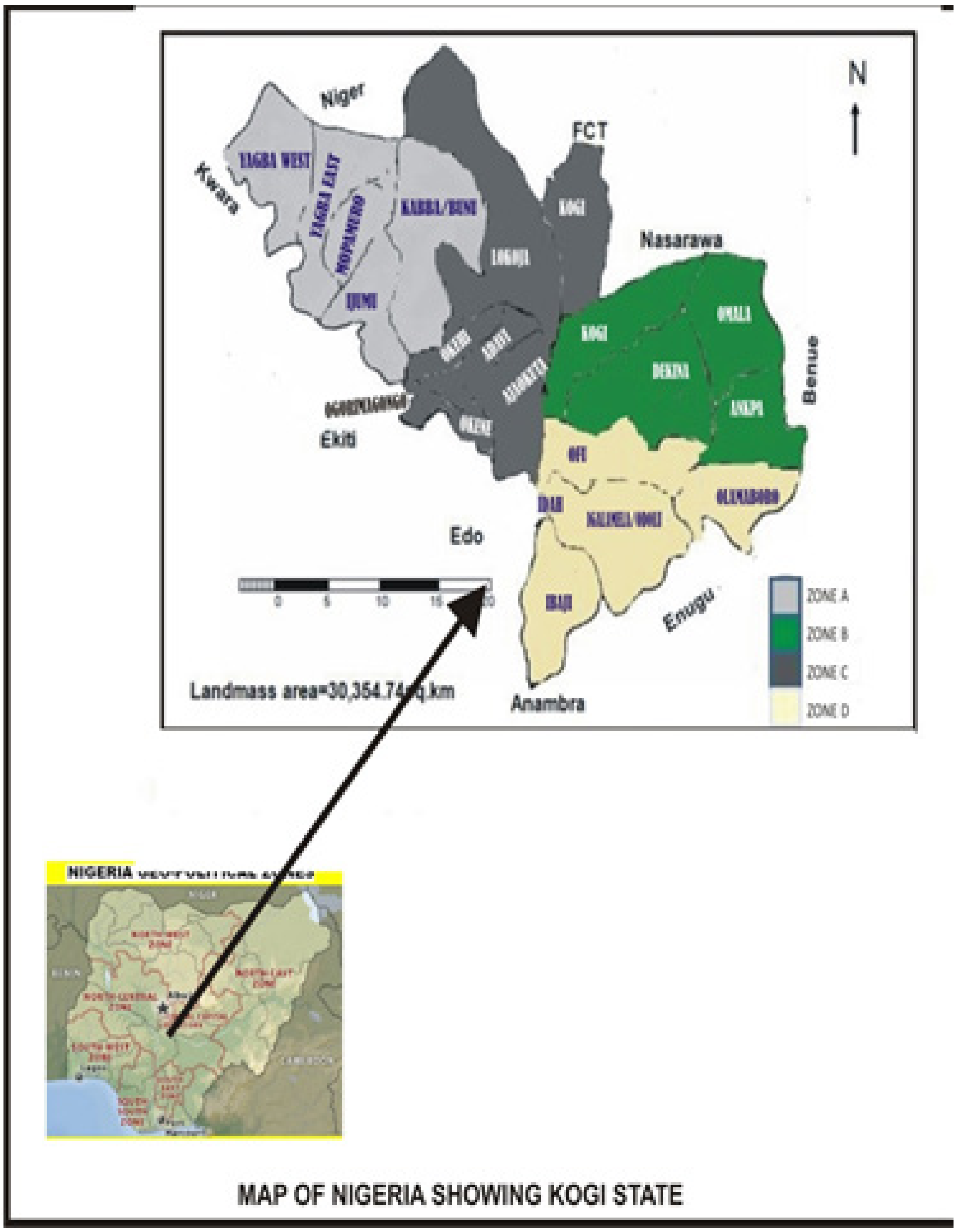

Figure 1: Map of Nigeria showing the Kogi Agricultural Zones

A multi stage random sampling technique was used to select the respondents. In stage one, three extension blocks were randomly selected from the existing extension blocks in the agricultural zones. In stage two, four (4) extension cells were randomly selected from each of the blocks. This gives 12 extension cells. In stage three, fifteen (15) crop farmers were randomly selected in each of the extension cells, giving a total of 150 crop farmers for the study.

Primary data used for the study were obtained using a structured questionnaire and analysed using descriptive statistics, sigma scoring, and Tobit regression model. The socioeconomic characteristics of crop farmers was described using descriptive statistical tools, while awareness and determinants of adaptation strategies were assessed using sigma scoring and Tobit regression model, respectively.

Sigma Scoring Method

The following step was used:

First obtain the percentage of crop farmers who are aware of the item:

$$\frac{\text{Number of crop farmers aware}}{\text{Total number of respondents}} \times 100 = A\%$$

This is followed by dividing the percentage (A %) by two and minus the answer from 100 - (A% / 2) =B%

Check B% on the statistical table of normal deviates to get the sigma distance (X). Next increase the value of the sigma distance using a constant figure of 2 and multiplying the result by the same constant.

$$(X + 2) \times 2 = Y$$

Since sigma method assigns weight in reverse direction on a 10 point scale, the actual sigma score would be 10 minus the answer (Y).

$$10 - Y = Z$$

Decision rule: Any mean score (Z) less than 5 was considered as low level of awareness on rainfall variability.

Tobit Regression Model

The Tobit model as adopted by Idrisa et al., (2012) was used to measure both the probability of use of adaptation practices and the intensity of use of such practices. The Tobit model assumes that use of adaptation practices is a continuous decision. It expresses farmer's use of adaptation practices as a function of linear combination of observable explanatory variables, some unknown parameters, and an error term (ε). The major strength of Tobit model over other econometric models, such as the Ordinary Least Square (OLS), is its inclusion of observations with non-use of adaptation practices. In its simplest form, the Tobit model is presented as:

$$\mu^{*}i = Bx_i + \mu$$

Algebraically expressed for the ith farmer, the Tobit model is explicitly expressed as:

$$\mu i = B_0 + B_1 X_1 + \ldots\ldots\ldots\ldots B_n X_n i = 1\ldots\ldots\ldots N$$

Where:

μ is the observed dependent variable i.e. adaptation to climate change, measured in the number of adaptation practices used by a farmer;

ß is the intercept or the level of adaptation that will occur regardless of the level of independent variable.

ß……. ß are coefficient of the independent variables.

X_1……..X_n are the independent variables selected based on economic theories and existing literature (Apata, et al. 2009; Deressa, et al. 2010; Franncis and Theophilus, 2011; Idrisa, et al. 2012).

X_1 = Age (in years)

X_2 = Sex (dummy: male = 1, female =0)

X_3 = Household size (number of person living in the household)

X_4 = Educational level (number of years spent schooling)

X_5 = Annual farm income (in Naira, ₦)

X_6 = Extension contact (number of times a farmer had contact with extension agent per farming season)

X_7 = Farming experience (number of years spent farming)

Unlike the OLS, the Tobit model coefficient does not directly correspond to the expected changes in explanatory variables; rather, it estimates a vector of normalized coefficients, which can be transformed into a vector of the first derivative (Tobin, 1958).

Results and discussion

Socio-Economic Characteristics of Respondents

Table 1 shows a mean age of 40 years. This implies that crop farmers in the area are still in their energetic and economically active age. This may however tilt towards the aged category overtime. The dominance of male could be attributed to intensive labour requirement of farming activities and men's easy access to farmland. Greater proportions of the respondents were married; this may increase access to productive resources such as land and labour. Marriage may have implications on agricultural labour as family members may serve as source of available labour for farming activities. The mean household size of 6 members is the same as the national average of 6 persons per household and could be described as relatively high. Large household size may have a two-way effect on crop production; labour availability and household expenditure.

Table 1 also shows that, most of the respondents could read and write; this may have implications on awareness and adaptation to climate change. This agrees with Okoye, et al. (2014) when they reported that educated farmers are expected to be more receptive to new and improved technologies than farmers with no formal education. The average year of farming experience of 10 years is long enough time to give credible evidence of climate change and its effects. Results further show a mean farm size of 2.0 hectares. This implies that farmers in the study area are mainly smallholder farmers and this may affect their adaptation strategies to arable crops, specifically. This agrees with Oyekale (2009), who reported that small-scale farmers operate at subsistent level, making them vulnerable and less able to cope with the consequences of climate change.

Awareness on the Effect of Climate Change

The distribution of respondents according to their awareness on the effect of climate change is presented in Table 2.

According to the data in Table 2, most of the respondents with sigma score of 5.714 were aware of climate change. This awareness could be created by weather forecasting organization such as the Nigerian Metrological Agency or by personal observation. This is aligned with Gehendra and Dinanath (2018) who reported that ninety eight percent (98%) of all villagers in Chitwan (India) recognize changes in the climate. Farmers are becoming increasingly conscious of local climate change issues.

Farmers in the study area were also aware of hotness in the environment and irregular rainfall due to climate change with sigma score of 5.30 for each. This agrees with Ikhile (2007) and Odjugo (2009) when they reported that the major problem of climate change is increasing atmospheric temperature which results in the hotness of the environment.

The farmers were also aware of reduction in crop yield with sigma score of 5.082; this has been a major concern to the farmers. This finding is in line with Sofoluwe et al. (2011) when they reported that there has been reduction in the yield of sorghum as a result of the effect of climate change. Other major effect of climate change include; fluctuation in rainfall (signma score = 5.026) and change in time of (sigma score = 5.064). Climate change could lead to the reduction in growing season as many farmers in the study area alleged they hardly get two to three planting periods.

Factors that Drives Adaptation to Climate Change by Crop Farmers

The Tobit regression result of factors that influence adaptation to climate change by crop farmers is presented in Table 3. The coefficient of F-value of 5.52 indicates that all variables included in the model significantly influence the probability of adapting to climate change at 1%. Out of the eight explanatory variables included in the model, four significantly influenced the probability of crop farmers adapting to climate change. Age, household size, membership of cooperative society, and number of extension contacts were significant in influencing the use of adaptation measures among the respondents.

Age was significant in influencing the use of adaptation measures among the respondents. The variable was significant at $p < 0.05$ and the sign of the coefficient was positive, implying that the older respondents used more adaptation measures compared to their younger counterparts. Age could serve as a proxy for farming experience or years spent farming; older farmers have greater tendencies to improvise and adopt new technologies because they are relatively more experienced, knowledgeable, more open to risk taking, and have longer planning horizons than their younger counterparts.

Household size was also significant in influencing the use of adaptation measure among the respondents. The variable was significant at $p < 0.05$ and the sign of the coefficient was negative, implying that smaller household used more adaptation measures compared to large household.

The results revealed that extension visits was significant in influencing the use of adaptation measures among the respondents. The variable was positive and significant at $p < 0.01$. This implies that as the number of contact with extension agent increases, the capacity to use the adaptation strategies correspondingly increases. This is in line with the study of Idrisa et al. (2010), who found that extension visits were significant in influencing both the likelihood of adoption and the intensity of use of improved soybean seeds.

The results further revealed that cooperative society was significant in influencing the use of adaptation measures among the respondents. The variable was positive and significant at $p < 0.05$. Farmers' association enables them to solve their agricultural problems among other things (Kehinde, et al. 2009). Membership of associations has been found to enhance the interaction and cross-fertilization of ideas among people (Bamire, et al. 2002). Farmers who are not members of associations are expected to have lower probabilities of access to credit source and its multiplier effect on the adoption of some adaptation strategies that requires fund.

Conclusion and recommendations

Increasing manifestation of the effect of climate change on crop productivity forms the thrust of this study. It was observed that crop farmers in Kogi agricultural zones, Nigeria were aware of change in climatic condition in recent time. Noticeable indicators of this change include hot environment, irregular rainfall, yield reduction and change in planting time. In a bid to reduce the vagaries of climate change, crop farmers changed their pattern of cropping and were also involved in crop diversification. These adaptation practices were positively influenced by age, membership of cooperative society and number of extension contacts.

Based on findings of this study, the following are recommended:

1. Extension service should be strengthened through adult education programmes for farmers to expose farmers to effective and efficient adaptation strategies to climate change.

2. Government and relevant stakeholders should support farmers to form and join agricultural cooperative societies to increase their adaptation capacities. This can significantly help them increase and sustain high levels of productivity even under changing climatic conditions.

3. Government and other relevant stakeholders (especially, the Kogi Agricultural Development Project) should embark on effective campaign on the consequences of climate change, especially in rural areas. Not only will it raise awareness, it will also create in-depth knowledge of human activities that are major contributors to climate change and expose the alternative ways of doing things. Provision of the right information on climate change will bring about effective and efficient adaptation.

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Anexes

Table 1: Distribution of Respondents by Socio-economic Characteristics (n = 150)

Socio-economic characteristics	Frequency	Percentage	Mean/Mode
Age			
20-40	40	26.67	
41-60	74	49.33	40 years
61-max	36	24.00	
Total	150	100.0	
Sex			
male	118	78.67	
female	32	21.33	Male
Total	150	100.0	
Marital Status			
Married	141	94.0	
Unmarried	9	6.0	Married
Total	150	100.0	
Household Size			
1-5	59	39.33	
6-10	73	48.67	
Above 10	18	12.00	6 persons
Total	150	100.0	
Educational Level			
No formal education	30	20.00	
primary education	47	31.33	
secondary education	41	27.33	Primary educ
Tertiary	32	21.33	
Total	150	100.0	
Farming experience			
1-10	63	42.00	
11-20	49	32.67	
21-max.	38	25.33	10 years
Total	150	100.0	
Farm Size			
0.1-3.0	42	28.00	
3.1-4.0	23	15.33	2.1Ha
Above 4.0	85	56.67	
Total	110	100.0	
Annual farm income			
> 50, 000	41	27.33	
50,001-150,000	28	18.67	₦66,000.1k
Above 150,000	81	54.00	
Total	150	100	

Source: Field Survey, 2018.

Table 2: Distribution of Respondents on their Level of Awareness on the Effect of Climate Change.

Awareness	No. of Respondents	Sigma Score
Aware of climate change	133	5.714
Fluctuation in rainfall	94	5.026
Frequent flooding	91	4.968
Yield reduction	97	5.082
Irregular rainfall	109	5.300
Hot environment	109	5.300
Common pest infestation	92	4.986
Change in crop growing season	96	4.834
Change in time of planting	84	5.064

Source: Field Survey, 2018.

Table 3: Regression Result of Factors that Influence Adaptation to Rainfall Variability.

Variables	Coefficient	Standard error	t	P>|t|
Age (years)	0.0277701	0.0139582	1.99	0.049**
Years spent farming	0.0213078	0.0166518	1.28	0.203
Household size (number)	-0.0718209	0.0326167	-2.20	0.029**
Years spent schooling	-0.005404	0.0225472	-0.24	0.811
Farm size (hectares)	-0.02904	0.026917	-1.08	0.282
Number of extension contacts	0.026156	0.009589	2.73	0.007***
Cooperative society (dummy)	0.4393988	0.2548959	1.72	0.087*
Annual farm income (₦)	1.29e-08	5.38e-08	0.24	0.810
Aware of rainfall variability (dummy)	0.4503147	0.4850677	0.93	0.355
Constant	3.189994	0.8662166	3.68	0.000***
Number of obs. = 150				
F(9, 141) = 5.52				
Prob > F = 0.0000				
Pseudo R^2 = 0.0609				

Source: Field Survey, 2018.

***,** and * denote 1%, 5% and 10% level of significance respectively.