EFFECTS OF INDIGENOUS ADAPTATION TECHNIQUES TO CLIMATE CHANGE ON SMALL-SCALE RUBBER FARMERS IN EDO AND DELTA STATES, NIGERIA

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ABSTRACT

The study evaluated the effects of indigenous adaptation techniques to climate change on small-scale rubber farmers in Edo and Delta States of Nigeria. Data were collected from 286 small-scale rubber producers using structure questionnaire. Data were analysed using descriptive statistic and multivariate probit regression model. Results showed that indigenous climate change adaptation techniques employed by respondents included inter-cropping, changing/adjusting dates of planting, use of firewood ash to control white root rot, use of palm kernel oil around tree, use of diesel around tree, changing farm size and planting different and more tolerant clones. Probit analysis revealed that age (b = 0.036), sex (2.843), household size (0.017), farm size (0.102), awareness of climate change effects (0.132) and attitude towards climate change effects (0.221) accounted for the farmers likelihood of being high users of indigenous climate change adaptation strategies. The study recommends that, local adaptation measures should be examined more closely to the understanding of the rationale behind their utility and how they can be integrated with scientific approaches to enhance their effectiveness.

Keywords: Indigenous; Adaptation techniques; Climate change; Rubber farmers.

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INTRODUCTION

Climate change has become a phenomenon in the world in recent times and the world has been experiencing its impacts. Climate change emanating from Global Warming has a lot of impact on the society and various institutions, for instance through unpredictable change in season, very high temperatures, and unreliable rainfall pattern. Today, there is no doubt that climate change is occurring, and that negative consequences are beginning to emerge. Many observers point to the increasing number of severe storms, flood sand, heat waves in recent years as indicators of changing climatic conditions. One of the sectors most sensitive to global warming is agriculture (Zoellick, 2009). Agricultural productivity in general could decline between 10 to 25 per cent by 2080 in Nigeria. For some parts of the country, the decline in yield in rain fed agriculture could be as much as 50% (Ozor*et al.*, 2010).

Rural households engaged in subsistence and smallholder farmers are most vulnerable to the impacts of climate change on agriculture. They may be affected in the following ways such as increased likelihood of crop failure; increase in diseases and mortality of livestock, and/or forced sales of livestock at disadvantageous prices; increased livelihood insecurity, resulting in assets sale, indebtedness, out-migration and dependency on food aid; and downward spiral in human development indicators, such as health and education (Oladipo, 2010). Such impacts will further aggravate the stresses already associated with subsistence production, such as isolated location, small farm size, informal land tenure, low levels of technology and narrow employment options, in addition to unpredictable and uneven exposure to world markets that smallholder farmers particularly risk-prone in the face of climate change (Adejuwon, 2006).

Farmers have a long history of responding to climate change; traditional and newly introduced adaptation strategies can help farmers to cope with both current climate change and future climate change (Adger *et al.,* 2007). Farmers often select crop combinations that will survive harsh conditions, such as maize-beans, cowpea-sorghum and millet-groundnut. According to Obinne (2010), possession of a wealth of indigenous knowledge should not be underestimated when it comes to small-scale farmers' ability to withstand climate change.

Planted rubber (budded stump) is grown between longitudes 15^0N and 10^0S where the climax vegetation is humid with temperatures ranging from 23 to 45^0C and a well- distributed rainfall of 1800 mm to 2000 mm on a well- drained soil (Aigbekaen *et al.,* 2000). Anything above or short of these pose a problem that can affect planted rubber (budded stumps) not to germinate (dormant, dried up) eaten up by pests and diseases (eg termite and white root-rot). Temperature has a great role to play in the flow of latex during tapping of mature rubber plant. According to Giroh *et al.* (2010), the survival rate of planted rubber (budded stumps) in southern Nigeria is very low because of pests and diseases infestation, variation in rainfall pattern and high temperature. This gives a pointer that climate change is already having negative effects on natural rubber production. Consequently, there is a need to develop an indigenous strategy to be able to cope with the effects of climate change. It is against this background that this study was conducted.

Objectives of the Study: The broad objective of the study is to evaluate effects of indigenous adaptation techniques of climate change on small-scale rubber farmers in Edo and Delta States, Nigeria.
The specific objectives were to:

i. identify the socio-economic characteristics of small-scale rubber farmers in the study area;
ii. ascertain small-scale rubber farmers' awareness of the effects of climate change in the study area;
iii. identify respondents' sources of information on the effects of climate change in the study area;
iv. ascertain indigenous adaptation techniques used by small-scale rubber farmers for mitigating climate change in the study area; and
v. identify barriers to climate change adaptation techniques used by small-scale rubber farmers in the study area.

Null (H_{O1}) Hypothesis: Socio-economic characteristics of small-scale rubber farmers have no significant effects on their practice of indigenous adaptation techniques to climate change.

METHODOLOGY

Area of Study: The study was conducted in Edo and Delta States, Nigeria. Edo State has a population of 3,218,332 which approximates to 2.4% of the total population of the country (NPC, 2006) and with a land area of 17,802km^2. The region lies within the rainforest zone and has a temperature range of 21 – 30^0C with a well distributed rainfall of 2000 mm annually (Aigbekaen*et al.*, 2000). It has ultisol soil with a pH range of 4.5 – 5.5 which is favourable for the production of natural rubber (Aigbekaen*et al.*, 2000).

Agriculture is the predominant occupation of the people in this state. The major economic trees produced are rubber and oil palm. In addition, the state produces such crops as yams, cassava, rice, plantain, guinea-corn, assorted types of fruits and vegetables.

Delta State has a population of 4,098,391 (NPC, 2006) and with a land area of 17,698 km^2 and a tropical climate marked by two distinct seasons-the dry and rainy seasons. The average annual rainfall is about 266.7 cm in the coastal areas and 190.5cm in the extreme north. Rainfall is heaviest in July. It has a high temperature, ranging between 29^0C and 34^0C with average of 30^0C. It has ultisol soil with pH range of 4.5 – 5.5 favourable for the production of natural rubber (Aigbekaen *et al.*, 2000). Economic trees, which abound in the state, include Sapele wood, Iroko, Mahogany, Raffia palms, rubber and palm trees.

Population and Sample Size Selection: A multistage sampling procedure was employed to collect data. The sample population of all the small-scale rubber farmers in Edo and Delta States is six hundred and two (602). The study collected data only half of the population size; 301 using structure questionnaire.

In the first stage of sampling, six Local Government Areas namely; Ikpoba-okha, Ovia South West, Uhunmwonde in Edo State and Ika-North, Ethiope West and Aniocha North in Delta State were selected purposively based on their high involvement in rubber production.

In the second stage of sampling, six major rubber producing communities from each Local Government Areas were selected. The final stage was the use of simple random sampling techniques in selecting farmers from each selected communities in proportion to the population. However, 286 respondents were the ones that accurately filled and returned their questionnaire for the analysis. The sampling plan for the study was presented in Table 1.

Method of Data Collection: Primary data were generated for the study using questionnaire and interview schedule. A structured questionnaire was designed to capture necessary information about the research objectives. The information included socio-economic characteristics of respondents, awareness of the effects of climate change, sources of information, indigenous adaptation techniques to mitigate climate change effects, and barriers to the use of climate change adaptation techniques by small-scale rubber farmers.

Method of Data Analysis: The analytical tools employed include descriptive and inferential statistics. The descriptive statistics such as percentage, frequency distribution and mean were employed.

Model Specification: Multivariate Probit Regression model was used to test the hypothesis. It is represented below:

$$Z = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7$$

Where:

Z = awareness of the effects of climate change (dummy: 1 = aware, not aware = 0)

A=constant (intercept)

b= coefficients of explanatory variables which increase or decrease z

X_1 = age (in years)

X_2 = sex (dummy variable: 1, if male, 0, if female)

X_4 = educational status (measure in years spent in school)

X_5 = farm size (in hectares)

X_6 = family size (number of people in household)

X_7 = farming experience (number of years involved in rubber production and sales).

Table 1: Sampling Plan

States	LGAs	Communities	Population of rubber farmers	Sample size (50% of the population)
Edo	Ikpoba-okha	Obayantor	12	6
		Imasabor	32	16
		ObagieN'evbnosa	16	8
		Uroho	16	8
		Okha	18	9
		Ologbo	20	10
	Uhunmwonde	Errua	12	6
		Iguezomo	16	8
		Ugha	8	4
		Igieduma	10	5
		Ehor	14	7
		Okeze	12	6
	Ovia South-West	Iguoriakhi	60	30
		Iguelaiho	12	6
		Osse	16	8
		Okomu	20	10
		Udo	8	4
		Ora-siluko	14	7
Delta	Ika North	Emuhu	8	4
		Uhumunede	18	9
		Mbiri	64	32
		Owerri-Olubor	12	6
		Ute-Ogbeje	8	4
		Ekwuoma	10	5
	Aniocha North	Isseleuku	20	10
		Idumuje-Unor	12	6
		Idumuje-Ugboko	16	8
		Ogodor	10	5
		Onitcha-Ugbo	12	6
		Ugbodu	14	7
		Jesse	12	6
		Boboroku	12	6
	Ethiope West	Mosogar	16	8
		Oghara	24	12
		Aghor	8	4
		Atighor	10	5
		Total	602	301

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents are presented in Table 2. The result shows that few (19.2%) respondents were above 60 years of age; most (39.5%) respondents belonged to the age bracket of 51 – 60years, 29% were 41 to 50 years old while 10.8% were 31-40 years. The results suggest that rubber farming is associated with moderately older persons. Similar finding has been reported by Abolagba *et al.* (2003) who found that those engaged in rubber production were fairly old farmers. Among the respondents, males constituted the majority (99.3%) whereas 0.7 percent was females. The predominance of males in rubber production may be attributed to the tedious nature and hard work involved in the production process.

The distributions of respondents according to their marital status showed that majority of the respondents (93.7%) were married. Analysis of the educational level of respondents revealed that farmers with formal education were in the majority (81.4%) whereas 18.5% had no formal education. Specifically, among those with formal education, most (50.3%) had primary education, 22.4% had secondary education whereas 8.7% had tertiary education. This implies that rubber farmers can go a long way to seek for vital information on climate change effects, because an educated mind is able to readily accept positive change. The result for household size showed that 40.60% of the respondents had a household size of 9 – 12 persons, 38.4% had less than 9 persons, whereas 21 percent had above 12 persons. The result shows that the respondents had large household size. This implies availability of family labour for rubber production. Banmeke and Omoregbe (2009) noted that large household size serves as an important source of farm labour supply.

Many (49%) of the respondents had a farm size of 2.1 – 4 hectares, 43% had less than 2 hectares, whereas 8% had more than 4 hectares. The mean size of the respondents' farm was 2.8 hectares. Seeking for information on climate change effects may be affected by small hectares and might be a disincentive in the acquisition of credit facilities from commercial banks. This supports the assertion of Delabarre and Serier (2000) that most Nigerian rubber farmers operate on less than four hectares and that the bulk of natural rubber production in Nigeria is in the hands of small-scale producers. Many (40.9%) of the rubber farmers had a farming experience of 11 – 20 years, 26.2% had less than 10 years, 25.2 % had 21-30 years whereas 1% had over 40 years. The result showed that the farmers were experienced in rubber farming. A similar finding was reported by Ugwa and Abubakar (2006) who found that most rubber farmers have a benefit of long years of accumulated experience in rubber farming.

Categorization of respondents based on awareness of climate change effects is shown in Table 3. Results showed that most (57.3%) of the farmers fell under the low awareness category while 42.7% fell under the high awareness category. The result implies that, on the average, majority of the respondents had a low awareness of the effects of climate change on rubber production.

Table 4 shows the respondents' sources of information on climate change. The result indicated that majority of the respondents (74.8%) sourced their information on climate change from friends/families. About 33.3%, 32.6% and 31.1% sourced their information from cooperative societies, Rubber Research Institute of Nigeria (RRIN) extension agents and radio, respectively. Few respondents sourced their information from Michelin agents (13%), Tree Crop Unit/Agricultural Development Programme (TCU/ADP) extension agents (9.6%), Print media (2.6%) and Television (1.1%).

Table 2: Socio-economic characteristics of respondents from Edo (n = 133) and Delta states (n = 153).

Characteristics	Categories	Delta (n = 133)			Edo (N = 153)			Pooled (n = 286)		
		Freq	%	Mean	Freq	%	Mean	Freq	%	Mean
Age (years)	≤ 30	2	1.5		2	1.3		4	1.4	
	31-40	17	12.8		14	9.2		31	10.8	
	41-50	36	27.1		47	30.7		83	29.0	
	51-60	57	42.9		56	36.6		113	39.5	
	61-70	21	15.8		34	22.2		55	19.2	
Sex										
	Female	1	0.8		1	0.7		2	0.7	
	Male	132	99.2		152	99.3		284	99.3	
Marital status	Married	126	94.7		142	92.8		268	93.7	
	Divorced	2	1.5		6	3.9		8	2.8	
	Widow(er)	5	3.8		5	3.3		10	3.5	
Education										
	No formal education	22	16.5		31	20.3		53	18.5	
	Primary school certificate	68	51.1		76	49.7		144	50.3	
	WASC/GCE/NECO	32	24.1		32	20.9		64	22.4	
	Tertiary education	11	8.3		14	9.2		25	8.7	
Income (₦) (annual)	250,000 & below	12	9.0		18	11.8		30	10.5	
	250,001-500,000	45	33.8		45	29.4		90	31.5	
	500,001-750,000	38	28.6		32	20.9		70	24.5	
	750,001-1M	10	7.5		23	15.0		33	11.5	
	1.1-1.25M	12	9.0		11	7.2		23	8.0	
	1.25-1.5M	4	3.0		3	2.0		7	2.4	
	>1.5M	12	9.0	684504	21	13.7	812608	33	11.5	733,035
Household size	0 - 4	14	10.5		29	19.0		43	15.0	
	5-8	35	26.3		32	20.9		67	23.4	
	9-12	60	45.1		56	36.6		116	40.6	
	>12	24	18.0	9	36	23.5	9	60	21.0	10
Farm size (ha)	0 – 2	51	38.3		72	47.1		123	43.0	
	2.1-4.0	73	54.9		67	43.8		140	49.0	
	4.1-6.0	9	6.8	2.4	14	9.2	2.2	23	8.0	2.8
Farming experience (years)	0 – 10	30	22.6		45	29.4		75	26.2	
	11-20	53	39.8		64	41.8		117	40.9	
	21-30	43	32.3		29	19.0		72	25.2	
	31-40	6	4.5		13	8.5		19	6.6	
	>40	1	.8	20	2	1.3	18	3	1.0	19
Total		**133**	**100**		**153**	**100**		**286**	**100**	

Note: M – Million Naira

Table 3: Categorization of respondents based on awareness of climate change effects

Awareness	Delta		Edo		Pooled	
	Freq	%	Freq	%	Freq	%
High awareness (Yes)	64	48.1	58	37.9	122	42.7
Low awareness (No)	69	51.9	95	62.1	164	57.3
Total	133	100.0	153	100.0	286	100.0

Table 4: Respondents' Sources of Information on Climate Change

Sources	Delta		Edo		Pooled	
	Freq*	%	Freq*	%	Freq*	%
Friends/family	94	72.3	108	77.1	202	74.8
Cooperative societies	46	35.4	44	31.4	90	33.3
RRIN extension agents	44	33.8	44	31.4	88	32.6
Radio	39	30.0	45	32.1	84	31.1
Michelin agents	19	14.6	16	11.4	35	13.0
TCU/ADP extension agents	14	10.8	12	8.6	26	9.6
Print media	3	2.3	4	2.9	7	2.6
Television	1	.8	2	1.4	3	1.1

**Multiple responses*

Indigenous climate change adaptation strategies used by respondents is presented in Table 5. All the respondents (100%) employed intercropping technique as a strategy to adapt to climatic change. This was closely followed by changing dates of planting (90.2%), use of firewood ash around tree to control white root rot (62.2%) and as well as palm kernel oil around budded stump to control termites (52.4%). Very few employed change of farm sizes (5.9%) and planting of tolerant clones (3.8%). The results therefore revealed that rubber farmers in the study area actually employed indigenous strategies to adapt to the effects of climate change. This is in line with finding by Obinne (2010), who reported that Africa should build on its strengths that are, its land, local resources, indigenous plant varieties, indigenous knowledge, and limited use of agrochemicals in order to attain food security and reduce the impact of climate change. Firewood ash is commonly spread around the base of rubber trees as a control measure for white root rot, which is a common rubber disease associated with heavy rains. To prevent termite attack, palm kernel oil is poured around budded stumps since the oil is known by rubber farmers to repel termites. United Nations Environmental Programme (UNEP) (2008) identified dire need to apply science and technology that is environmentally friendly in the field of agricultural productivity by using sustainable agricultural practices that minimize harm to the environment and build soil fertility. The implication of this finding is that respondents with low income can cope or adapt with the effects of climate change with little or no reduction in their output. The result agrees with Mekelle (2010) who found that most common adaptation strategies include use of different crop varieties, soil and water conservation, changing planting dates, and use of short growing crops.

Barriers to respondents' use of climate change adaptation techniques is as presented in Table 6. The major constraints include low capital (91.3%), poor infrastructural facilities (85.7%), high cost of inputs (83.9%), inadequate information on climate change (82.2%), inadequate credit facilities (75.9%), poor contact with agricultural extension agents (71.3%) and government ineptitude and unresponsiveness to climate change issues as they affect agriculture and rubber farming in particular (66.4%). The implication of this finding is that inadequate capital limits strategies that the farmer can employ since many of these have cost implications, for example, the use of palm kernel and diesel oil. This situation is further worsened with the absence of credit facilities. Where agricultural extension service is lacking, inadequate or ineffective, farmers may be limited as to the comprehensiveness of information they may receive on climate change. Sometimes information from family and friends may be highly unreliable as some authors have noted that such channels of farm information may not be held in high credibility by farmers (Deressa, 2008; Ozor *et al.,* 2010)

Table 5: Indigenous climate change adaptation strategies used by respondents

Strategies	Delta		Edo		Pooled	
	Freq	%	Freq	%	Freq	%
Inter-cropping	133	100.0	153	100.0	286	100.0
Changing of planting dates	120	90.2	138	90.2	258	90.2
Use of firewood ash around tree (to control white root rot)	84	63.2	94	61.4	178	62.2
Use of palm kernel oil around budded stump (to control termites)	69	51.9	81	52.9	150	52.4
Use of diesel oil around budded stump (to control termites)	42	31.6	41	26.8	83	29.0
Changing farm size	4	3.0	13	8.5	17	5.9
Planting different and more tolerant clones	6	4.5	5	3.3	11	3.8

The relationship between respondents' socioeconomic characteristics and their use of indigenous climate change adaptation strategies is as shown in Table 7.. The Chi-square test (1167936.376) was significant at the 5% level, indicating that the model was appropriate for the analysis. Out of the ten (10) variables specified in the in the model, seven (7) were significant at the 5% level. The coefficient for age was positive and significant (b = 0.036) implying that the older farmers were likely to be high users of indigenous climate change adaptation strategies. It is possible that experience arising from age has made older rubber farmers appreciate the use of the indigenous adaptation strategies in coping with effects of climate change. Respondents attitude towards climate change also was positively and significantly (b = 0.221; $p<0.050$) related to their use of indigenous climate change adaptation strategies. The positive relationship means that farmers with positive attitude towards climate change were likely to be high users of indigenous climate change adaptation strategies. An explanation for this could be those farmers having a positive disposition to climate change issues are more likely to engage any efforts that will mitigate or solve the problems caused by climate change.

Awareness of climate change effects by respondents was positively and significantly (b = 0.132) related to their use of indigenous climate change adaptation strategies. The positive sign implies that respondents having high level of awareness of climate change effects were likely to be higher users of indigenous climate change adaptation strategies. This is because such level of awareness will make the farmers seek for coping measures to deal or manage the harmful effects of climate change.

Table 6: Barriers to respondents' use of climate change adaptation techniques

Barriers	Delta		Edo		Pooled	
	Freq	%	Freq	%	Freq*	%
Poor/low income	124	93.2	137	89.5	261	91.3
Poor infrastructure facilities	109	82.0	136	88.9	245	85.7
High cost of farm inputs	116	87.2	124	81.0	240	83.9
Poor/inadequate climate change information	91	68.4	144	94.1	235	82.2
Poor credit facilities	105	78.9	112	73.2	217	75.9
Poor/inadequate agricultural extension service delivery	92	69.2	112	73.2	204	71.3
Inadequate labour	86	64.7	116	75.8	202	70.6
Government irresponsiveness to climate change risk	95	71.4	95	62.1	190	66.4
Land tenure problem	31	23.3	65	42.5	96	33.6

**Multiple responses*

Table 7: Relationship between respondents' socio-economic characteristics and their use of indigenous climate change adaptation strategies

Independent variables	Coefficients (b)	Z-values	Prob. level
Age (years)	0.036*	11.032	0.000
Sex	2.843*	2.801	0.005
Education	-0.007	-0.188	0.851
Household size	0.017*	3.068	0.002
Farm size	0.102*	3.148	0.002
Farming (rubber) experience	-0.001	-0.367	0.713
Income	0.005	0.218	0.827
Awareness of climate change effect	0.132*	8.601	0.000
Respondents' contact with extension agents	0.125*	2.088	0.037
Attitude towards climate change	0.221*	9.683	0.000
Intercept	-13.017	-11.258	0.000

Pearson Goodness-of-Fit Test (Chi-Square Tests = 1167936.376; df = 275; p<0.050)
**Significant at the 5% (critical t = 1.96)*

Farm size (b = 0.102) was another significant determinant of the use of indigenous climate change adaptation strategies by respondents. Its positive sign implies that larger farm holders were more likely to be high users or make more use of indigenous climate change adaptation strategies.

Household size of the farmers was, also, a major determinant affecting their use of indigenous climate change adaptation strategies. Results shows that household size (b = 0.017) was positive signed indicating that farmers with larger families were likely to be high users of indigenous climate change adaptation strategies. An explanation for this may be that they have access to family labour and therefore do not need to pay for use of labour in carrying out some of the adaptation strategies. Giroh *et al.* (2006) reported the positive impact of household size on farmers' use of adaptation strategies. Respondents contact with extension agent (b = 0.125) had a positive and significant relationship with their use of indigenous climate change adaptation strategies. The positive sign by this study suggests that those having contact with the agents were more likely to be high users of indigenous climate change adaptation strategies. Olaniyi (2010) noted that contact with extension agents' exposes a farmer to information that helps him/her better manage his farm enterprise.

CONCLUSION AND RECOMMENDATIONS

- Major indigenous climate change adaptation strategies employed by respondents included inter-cropping (100%), changing/adjusting dates of planting (90.2%), use of firewood ash to control white root rot (62.2%) and palm kernel oil around tree to control termites (52.4%).
- Based on the adaptation strategies used majority of the respondents were classified as high users (72%) of indigenous climate change adaptation strategies.
- In view of these, it was recommended that in promoting indigenous climate change adaptation strategies/techniques among small-scale rubber farmers in the study area, the local adaptation measures should be studied more closely to understand the rationale behind their utility and how they can be integrated with scientific approaches to enhance their effectiveness.

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