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Analysis of Perceived Effect of Climate Change and Adaptation among Cocoa Farmers in Ikwuano Local Government Area of Abia State, Nigeria

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ABSTRACT

The study analysed perceived effects of climate change and adaptation strategies among cocoa farmers in Ikwuano Local Government Area of Abia State, Nigeria. Multi-stage random sampling technique was used in selecting one hundred and ten cocoa farmers. Instrument for data collection was through a structured questionnaire and analysed using both descriptive and inferential statistics. The results revealed that the cocoa farmer's population was young with a mean age of 36.70 years. About half (50.0%) and 22.7% of the respondents used household labour and hired labour respectively in their plantations. The mean farming experience of the respondents was 17.90 years, with mean farm size of 4.7 hectares and annual mean farm income of ₦ 503927.273. Farmers perceived that high rainfall ($\bar{X} = 3.07$), reduced weight ($\bar{X} = 2.84$), high disease infection ($\bar{X} = 2.76$), reduced quality ($\bar{X} = 2.75$), and high sunshine ($\bar{X} = 2.56$) had effects on cocoa production. Cocoa farmers frequently used application of chemicals ($\bar{X} = 3.30$), pruning and chupon growth ($\bar{X} = 3.15$) and intercropping ($\bar{X} = 3.11$), change varieties and coppicing ($\bar{X} = 3.00$), shedding technique during nursery and first two years of transplanting ($\bar{X} = 2.85$), lift irrigation system and increase in price of cocoa per bag ($\bar{X} = 2.84$) respectively, switch to other sources of income ($\bar{X} = 2.59$) and spending more money on disease prevention. Multiple regression result showed that age, household labour, hired labour, farm size, farm income, farming experience and rainfall were determination of effects of climate change among cocoa farmers in the study area. It was recommended that cocoa farmers should be trained in seminars on climate change and mitigation, chemical application, processing and storage technologies for increased cocoa production.

Keywords: *Perception, effect, climate, climate change, adaptation, cocoa, farmer*

1. INTRODUCTION

Climate change and agriculture are interrelated processes, both of which take place on global scale (Climate Education Module, 2010). Global warming in form of temperature, carbon-dioxide, glacial run-off, precipitation and the interaction of these elements is projected to have significant impact on conditions affecting agriculture. The overall effect of climate change on agriculture will depend on the balance of these effects (Olowa *et al.,* 2009). The term "climate change" often refers only to changes in modern climate, including the rise in average surface temperature known as global warming (UNFCCC, 2001).

Kadapt is a prime focus on many adaptation projects (FAO, 2001). Many farmers in the cocoa producing areas in Nigeria, especially Ikwuano LGA, are ignorant of adapting strategies in combating climatic change effect on cocoa production. In this regard this study was designed to analyze of perceived effect of climate change and adaptation among cocoa farmers in Ikwuano Local Government Area of Abia State, Nigeria. The Specific objectives were to;

i. describe socio-economic characteristics of cocoa farmers in the study area
ii. ascertain perceived effect of climate change variabilities on cocoa production and
iii. ascertain adaptation strategies adopted by cocoa farmers in adjusting to the effects of change in climatic factors.

2. HYPOTHESIS

H_0: Socio-economic factors of cocoa farmers such as sex, age, household labour, hired labour, farm size, farming experience, farm income, and rainfall do not have significant effect on climate change variabilities in cocoa production.

3. MATERIALS AND METHODS

The study was conducted in Ikwuano Local Government Area of Abia State, Nigeria. It is an agricultural practicing area. It is located at latitude $5^0 26^1$N $7^0 34^1$ and 5.433^0N 7.567^0E. The rainfall pattern and temperature varies seasonally. The rainy season begins in April and ends in October with a break in August and dry season last from November to March. The total rainfall decreases from 2200mm in the south to 1900mm in the north. The hottest months are January to march when the mean temperature is above 27^0C (NMS, 2001).

Ikwuano is bounded on the north by Bende and Umuahia Local Government Areas, Isiala-ngwa on the west and has twenty-seven (27) autonomous communities. The occupation of the people reflects the economic characteristics of the area. It is known to be one of the largest primary producers of export cash crops (palm produce, cocoa etc.). The major farm crops grown include

cassava, yam, maize, melon, plantain, banana etc. and has vast areas of rich arable land (Smart, 2001).

Multi-stage random sampling technique was used in the selection of communities, villages, and cocoa farmers. First, four (4) rural communities were purposively selected from the Local Government, namely Oboro, Ibere, Obi Ibere and Ariam. This was because; cocoa production is the major agricultural economic activity in the communities. Second, two (2) villages each wLge in climatic factors and its effects on cocoa and farmers adaptation strategy components were each ascertained using the 4 point Likert type scale. It is represented according to Fakoya and Daramola (2008); quoted in Nwaobiala (2013) as:

Change in climatic factors, its effects and adaptation strategies = $4(N_1) + 3(N_2) + 2(N_3) + 1(N_4)$
The means were calculated for each of the change, its effects and adaptation strategy components.

$$M = \frac{4(N_1) + 3(N_2) + 2(N_3) + 1(N_4)}{S}$$

Where:

M = Mean of perception, its effects and adaptation strategy components
N = Number of cocoa farmers
S = Sample size of cocoa farmers

The multiple linear regression was used to determine the perceived effects of climate change variabilities on cocoa production and is expressed in accordance with Olawuyi *et al;* (2012) as:

$$Y = B_0 + B_i + B_i X_i + \mathcal{E}_i$$

Where: Y = Dependent variable (cocoa production level in tones/annum)

B_0 = Intercept (constant)
B_i = Regression coefficients of the Selected socio-economic characteristics of cocoa farmers and effects of change in climatic factor
X_i = Vectors of parameters to be estimated, i.e explanatory var-iables (I = 1, 2, 3 … 8)

X_1 = Sex (male = 1, otherwise 0), X_2 = Age (years), X_3 = Number of household labour, X_4 = Number of hired labour, X_5 = Farm size (Ha), X_6 = Income level (₦), X_7 = Experience in cocoa production (years), X_8 = Rainfall (yes = 1, otherwise 0)

$\mathcal{E}_i$ = Error term or random error included to account for explanatory variables which are not taken into account

The selection of these variables is similar in the study of Onumadu *et al.,* (2012).

4. RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of cocoa farmers' in the study area

Table 1 presents the socio-economic characteristics of cocoa farmers. The result reveals that majority (81.8) of cocoa farmers in the study area were males. This result is in accordance with the findings of Oluwatusin *et al.,* (2014) that cocoa production is dominated by men as a result of the nature of operations involved in its production implying that owners of cocoa farms are mostly men. Also Ozor and Nnaji (2010) support the observation that more males involve in farming and type and quality of work done is determined by the sex of an individual.

The mean age of cocoa farmers was 36.7 years. This shows that the farmers are in their productive ages and can overcome a lot of drudgery involved in cocoa production as well as effectively employing adaptative strategies. The mean farm size of the respondents was 4.7 hectares while 22.7% and 50.0% used household labour and hired labour respectively.

More also, the farmers had a mean farming experience of 17.9 years with annual farm income of ₦ 503,927.273. The result is consistent with Nwaobiala (2013) who asserts that with more experience, farmers are able to cope with risk associated with climate change in farming activities hence climate change adaptation.

Table 1: Percentage and mean distribution of selected socio-economic characteristics of cocoa farmers in the study area.

Variable	Indices
Gender	81.8% (Males)
Age	36.7years (Mean)
Household labour	22.7 Percent
Hired labour	50.0 Percent
Farm size	4.7hectares (Mean)
Farm income	₦ 503,927.273 (Mean)
Farming experience	17.90 years (Mean)

Source: Field survey, 2013

4.2 Perception of change in climatic factors and its effects on cocoa

The result in Table 2 reveals that a moderate proportion (55.5%) of cocoa farmers affirmed that rainfall and temperature with mean rating of 3.31 were the most important perceived effects in cocoa production. This is followed by high rainfall and reduced weight with mean ratings of 3.07 and 2.84 respectively. Okoli *et al;* (2004) in Onumadu *et al;* (2012) observed that tree crops can be affected by rise in sunshine and rainfall which has adverse

effect on productivity and protection practices like spraying of pesticides, herbicides among others.

Furthermore, farmers asserted that high disease infestation ($\bar{X}$ = 2.76) and reduced quality ($\bar{X}$ = 2.75) and high sunshine ($\bar{X}$ = 2.76) were perceived effects of climate change on cocoa production in the study area. Okoli and Ewah (2004) in: Onumadu (2012) reported that crops can be depressed by rise in sunshine and temperature from global warming.

Table 2: Distribution of respondents according to perception of change in climatic factors and its effects on cocoa (n = 110)

Change in Climatic Factors and Its Effects	Agreed (4)	Disagreed (3)	Strongly Agreed (2)	Strongly Disagreed (1)	Mean score
Rainfall and Temperature (the most Important Climatic Factors in Cocoa Production)	61(55.5)	27(24.5)	17(15.5)	5(4.5)	3.31
High Rainfall	35(31.8)	55(50.0)	13(11.8)	7(6.4)	3.07
Reduced Weight	29(26.4)	47(42.7)	21(19.1)	13(11.8)	2.84
High Disease Infestation	25(22.7)	48(43.6)	23(20.9)	14(12.7)	2.76
Reduced Quality	20(18.2)	62(56.4)	8(7.3)	20(18.2)	2.75
High Sunshine	28(25.5)	26(23.6)	36(32.7)	20(18.2)	2.56
Low Rainfall	13(11.8)	18(16.4)	56(50.9)	23(20.9)	2.19
Unfavourable Rainfall	32(29.1)	37(33.6)	21(19.1)	20(18.2)	1.90

Source: Field Survey, 2013
Decision Rule 2.50 and above = Favourable
Decision Rule <2.50 = Unfavourable
Values in Parenthesis are Percentage

4.3 Levels of cocoa farmers adaptation strategies adopted in the study area

Table 3 shows that most (63.5%) of cocoa farmers ascribed that application of insecticide with mean rating of 3.30 was adaptation strategy they frequently used. Also, pruning affected parts and chupon growth (59.1%) and intercropping (53.6%) with mean ratings of 3.15 and 3.11 respectively were adopted. Nwaobiala (2013) confirmed that application of chemicals such as Diuron against black pod infestation resulting from climate change has proved to be effective. Pruning of affected parts and chupon growth is an important adaptation strategy in cocoa production that prevent spread of diseases to other parts of the cocoa tree and other cocoa trees thereby enhancing health of the cocoa trees and output (Obatunde *et al*; 2003).

Furthermore, the cocoa farmers engaged in changing varieties or coppicing ($\bar{X}$ = 2.99), shedding technique during nursery and first two years of transplanting ($\bar{X}$ = 2.85), lift irrigation system and increase in price of cocoa per bag ($\bar{X}$ = 2.84) respectively. Lastly, cocoa farmers involved in switching to other sources of income ($\bar{X}$ = 2.59) and spending more money on disease prevention and labour ($\bar{X}$ = 2.57). This implies that, cocoa farmers were usually engaged in the adaptation strategies as the means are greater than 2.50. This result collaborates with Nwaobiala, 2013 technologies can go a long way in enhancing yield which increases cocoa production.

In addition, only those who perceive climate change will consider the need to adapt to it. Adaptations are the necessary interventions needed to manage the losses or take advantage of the opportunities presented by climate change (IPCC, 2001).

Table 3: Distribution of respondents by adaptation strategies to effects of climate change on cocoa production (pooled data = 110)

Variables	Frequently Used (4)	Occasionally Used (3)	Rarely Used (2)	Not Used (1)	Mean Score
Application of chemicals (pesticides, herbicides etc.)	70(63.5)	16(14.5)	11(10.0)	13(11.8)	3.30
Pruning Affected Parts/Chupon Growth	65(59.1)	12(10.9)	18(16.4)	15(13.6)	3.15
Intercropping	59(53.6)	21(19.1)	13(11.8)	17(15.5)	3.11
Change Varieties/ Coppicing	43(39.1)	37(33.6)	16(14.5)	15(12.7)	3.00
Shedding Technique During Nursery and First Two Years of Transplanting	39(35.5)	31(28.2)	25(22.7)	15(13.6)	2.85
Lift Irrigation System (Stream)	47(42.7)	20(18.2)	21(19.1)	22(20.0)	2.84
Increase in Price of Cocoa Per bag	22(20.0)	57(51.8)	22(20.0)	9(8.2)	2.84
Switch to Other sources of Income	24(21.8)	37(33.6)	29(26.4)	20(18.2)	2.59
Spend more money on labour and Disease Prevention	22(20.0)	42(38.2)	23(20.9)	23(20.9)	2.57
Change from Cocoa Production to Cultivation of other Crops	17(15.5)	26(23.6)	41(37.3)	26(23.6)	2.31
Application of Fertilizer	26(23.6)	18(16.4)	13(11.8)	53(48.2)	2.15
Change Fertilizer	12(10.9)	18(16.4)	18(16.4)	62(56.4)	1.98

Source: Field Survey, 2013.
Decision Rule 2.50 and above = Adaptation strategy
Decision Rule <2.50 = Not Adaptation strategy
Values in parenthesis are percentages

4.4 Determination of perceived effects of climate change variabilities on cocoa production in the study area

The socio-economic characteristics and climatic change effects on cocoa production level are shown in Table 4. The semi-log functional form was chosen as lead equation based on the number of significant variables and the conformity to apriori expectation. The co-efficient of multiple determination (R^2) implied that 66.7% of the level of variations in the cocoa production level of farmers was due to the changes in the specified explanatory variables included in the model. The F-ratio was significant at 1% indicating the goodness of fit of the model.

The result shows that coefficient of age (-1.287) was negative and significant at 10%, this indicates that the higher the age, the lower the level of production because aged farmers are conservative and are indifferent in participating in programme technologies that are yield enhancing which increase level of cocoa production in the study area.

The coefficient for household labour (2.904) and hired labour (4.342) were positive and significant at 5% and 1% respectively. This implies that, the higher the labourers, the better the level of cocoa production. For every additional 1 labourer, level of cocoa production increases by 5.5% and 9.1% respectively and also are strong factors to consider. The coefficient for farm size (4.370) was positive and significant at 1%, this indicates that, for every 1 hectare increase in farm size, cocoa production level increases by 9%; this is in line with the a-priori expectation and it is attributed to the fact that increased level of cocoa production result more from expanding their enterprise by panting improved varieties of cocoa seedlings than intensification of production. Intensive cocoa production will natural, require the use of more adaptation measures like chemical (herbicides, pesticides, insecticides and fertilizer) application. The coefficient for farm income (3.516) was positive and significant at 5%, this implies that there is no inverse relationship between level of production as a measure of climate change effect on cocoa production and farm income; meaning that as farmers' income increases, cocoa production level also increases; it is an important factor to consider. The coefficient for farming experience (1.310) was positive and significant at 10% which implies that, the more the experience, the more the level of cocoa

production because high experienced farmers have tendency to practice better adaptation strategies and have a valuable asset in adoption decision-making as the years of cocoa farming experience increases. The coefficient for rainfall (3.527), was positive and significant at 1% which means that, high rainfall leads to high level of cocoa production. This finding indicates that rainfall contributes significantly and positively to level of cocoa production in the study area in-spite of climate change. On the other hand, pest and disease infection can drive well in high humidity area. Furthermore, Climate change has not altered the most essential natural resources required for cocoa production processes (land, water, sunshine, air and temperature, and soil conditions) in the study area in such a way as to reduce level of cocoa production against the a-priori expectation. In addition, this finding further lends credence to our previous finding on perception in which cocoa farmers disagreed on the identified negative effects of change in climate on cocoa production.

This finding did not provide enough evidence to agree with Onumadu and Okore (2012) that climate change leads to less output in Agricultural production in Arochukwu Local Government Area of Abia State which has similar climate conditions with Ikwuano Local Government Area of Abia State. Hence, from the above finding, the null hypothesis is rejected and it is thus concluded that socio-economic factors such as gender, age, household labour, hired labour, farm size, farm income, farming experience and rainfall have significant effect on climate change variabilities in cocoa production in the study area.

Table 4: Regression estimates of factors influencing climate change variabilities on cocoa production in the study area.

Variables	Linear	Exponential	Double	Semi-log^{+}
Constant	-26.748 (-0.810)	-756.794 (-1.984)*	-3.027 (-0.475)	2.445 (3.001)***
Gender (X_1)	6.710 (1.139)*	0.063 (0.002)	0.040 (0.082)	0.144 (0.989)
Age (X_2)	0.445 (0.285)	192.027 (1.182)*	-0.875 (-0.322)	-0.050 (-1.287)*
Household Labour (X_3)	0.308 (0.400)	5.575 (0.620)	0.201 (1.341)*	0.055 (2.904)**
Hired Labour (X_4)	0.892 (1.047)*	11.941 (0.920)	0.311 (1.436)*	0.091 (4.342)***
Farm Size (X_5)	5.060 (6.075)***	18.810 (1.869)*	0.250 (1.486)*	0.090 (4.370)***
Farm Income (X_6)	1.139 (4.070)***	16.265 (2.388)**	0.450 (3.956)***	2.426 (3.516)**
Farming Experience (X_7)	-0.637 (-0.401)	-73.417 (-0.965)	0.466 (0.367)	0.051 (1.310)*
Rainfall (X_8)	5.048 (0.875)	12.012 (0.344)	0.697 (1.196)*	0.075 (3.527)***
R^2	0.659	0.547	0.679	0.667
Adj.R^2	0.625	0.406	0.579	0.633
F. ratio	19.141***	3.868***	6.773***	19.792***

Source: Field Survey, 2013

Where: *****, **, *** = Significant at 1%, 5%, and 10% respectively
+ = Lead equation
Values in parenthesis are t-ratios.

5. CONCLUSIONS AND RECOMMENDATION

Based on the findings, cocoa farmers' perceived that high rainfall, reduced weight, high disease infestation, reduced quality, high sunshine were perceived factors for climate change vulnerability in the study area. Adaptation strategies employed by farmers to ameliorate effects of climate change on cocoa production were application of chemicals (pesticides, fungicides, herbicides), pruning affected parts and chupon growth, intercropping, change varieties and coppicing, shedding technique during nursery and first two years of transplanting, lifts irrigation system, and increase in price of cocoa per bag. The factors that influenced cocoa farmers' production in the study area were age, household labour, hired labour, farm size, farm income, farming experience, and rainfall. The study therefore recommends that: cocoa farmers in the study area should be trained in seminars on climate change and mitigation, chemical application, processing and storage technologies for increased cocoa production.

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