RGA Global Journal of Multidisciplinary Research
ISSN : XXXX-XXXX | Vol 1, Issue 1, Jan – Feb, 2026
Published by RGA Research Publications

Determinants of Adaptation Strategies to Climate Change by Plantain Farmers in the Aguata Agricultural Zone of Anambra State, Nigeria

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Received: 10 Jan 2026 | Accepted: 28 Jan 2026 | Published: 09 Feb 2026

ABSTRACT

The study examined the determinants of climate change adaptation strategies by plantain farmers in the Aguata Agricultural Zone of Anambra State, Nigeria. A purposive sampling technique was adopted in selecting 120 plantain farmers that formed the sample size. A structured questionnaire was used for data collection. Descriptive and inferential statistics were used in analyzing the data obtained. The findings revealed high incidences of rising temperatures, excessive rainfall, and pests and diseases. Results indicate that the determinants of the adaptation strategies used were drought-resistant planting materials, disease-resistant varieties, mulching, organic manuring, precision farming, rainwater harvesting, drip irrigation, agroforestry practices, and socioeconomic factors such as education level and the cost of adaptation strategies. This study also revealed a high coefficient of determination of $R^2 = 0.76$, which is equivalent to 76%. The study concluded that climate change has a negative effect on plantain production in the study area. The study recommends that relevant stakeholders should support farmers by providing single-digit loans and incentives to enable them to meet the financial obligations needed to apply the adaptation strategies at the right time.

Keywords: Determinants, Incidences, Climate change, Plantain farmers, Adaptation.

INTRODUCTION

Plantain (*Musa paradisiaca* and *M. acuminata* x *balbisiana*) belongs to the family of flowering plants known as Plantaginaceae and Genus: *Platanus*, commonly known as plantains, belonging to the kingdom Plantae; Phylum Magnoliophyta. There are two main varieties and species of plantain, which include Horn and French Horn. Three main types of plantain species exist alongside many minor plantain species, namely: Hybrid, Horn plantain, and False Horn plantain.

Plantain is ranked third among starchy staples and is a major carbohydrate food for many people, including in Nigeria (Ebe et al., 2021; NEST, 2024; ECCC, 2024). Plantain is an important food crop in Nigeria, Aguata inclusive. However, it is not yet grown as an organized crop because production and processing are still done by micro-producers. Production is constrained by inadequate funds, poor cultural practices, climate change and variability, as well as poor manpower resources and water management (Njoku & Ugboaja, 2019; NBS, 2023). Facts on climate change,

as reported by the Nigerian Environmental Study/Action Team (NEST, 2024), outlined issues such as poor nutrition, low agricultural yields, poverty, proliferation of disease vectors and pests, sleeping sickness, soil erosion, and other impacts of climate change.

The broad objective of this study was to examine the determinants of climate change adaptation strategies among plantain farmers in the Aguata Agricultural Zone of Anambra State, Nigeria. The specific objectives are to: identify the incidences of climate change, and ascertain the adaptation strategies used by the farmers to reduce the impacts of climate change on plantain production. This study assumed the null hypothesis (H_{01}): There is no significant relationship between climate change incidences and the adaptation strategies used by farmers in the Aguata Agricultural Zone of Anambra State.

METHODOLOGY

The study was conducted in the Aguata Agricultural Zone of Anambra State, Nigeria. Aguata is located in the South-East Region of Nigeria. The Aguata Agricultural Zone is located between latitudes 6° and 40° North of the Greenwich Meridian. A multi-stage and purposive sampling procedure was used in the selection of respondents for the study.

1. **First Stage:** Involved the selection of the Aguata Agricultural Zone in Anambra State. The choice of the Aguata Agricultural Zone was informed by the notable position of the area in plantain production. Also, the Aguata Agricultural Zone has an excellent environment with both upland and lowland areas, which favors plantain production (ASADEP, 2021; Anambra State Ministry of Agriculture, 2021).
2. **Second Stage:** Consisted of the purposive selection of two extension blocks, namely Aguata and Orumba North blocks. The reason for their selection was based on the intensity and high concentration of plantain farmers in the study area.
3. **Third Stage:** Three (3) circles were selected randomly from each of the selected blocks, making a total of six circles, namely: Uga, Ekwulobia, and Awara in the Aguata block, and Obiofia, Otolo, and Obolo. Selection was based on the proximity and convenience of the researcher.
4. **Fourth Stage:** Comprised the selection of two (2) sub-circles from each of the six (6) circles, making twelve (12) sub-circles, namely: Umuhu, Uga, Igbo-Ukwu, Umuchu, Achina, Amsi, Aguluezechukwu, Nmesi, Ezinifite I, Ezinifite II, Ikenga, and Isuofia.
5. **Final Stage:** Involved selecting ten (10) plantain farmers from each of the twelve (12) sub-circles, making a total of 120 plantain farmers involved in the study, which formed the sample size.

Data for the study came from the respondents with the use of a structured questionnaire administered to the 120 respondents. Data obtained from the study were analyzed using descriptive and inferential statistics, while multiple regression analysis was adopted to test the hypothesis.

Model Specification

Multiple regression was used to analyze the factors that influence the plantain farmers' adaptation strategies to climate change in the study area. The multiple regression model is implicitly expressed as:

$$Y = f(X_1, X_2, \dots, X_n) + e_i$$

However, the model is explicitly specified across four functional forms:

1. **Linear function:**

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e_i \quad \text{... (Eq. 1)}$$

2. **Exponential function:**

$$\ln Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e_i \quad \text{... (Eq. 2)}$$

3. **Semi-log function:**

$$Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \dots + \beta_n \ln X_n + e_i \quad \text{... (Eq. 3)}$$

4. **Double-log function:**

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \dots + \beta_n \ln X_n + e_i \quad \text{... (Eq. 4)}$$

Where:

- Y = Determinants of climate change adaptation strategies by plantain farmers
- X_1 = Gender (male = 1, female = 0)
- X_2 = Age (years)
- X_3 = Farm size (hectares)
- X_4 = Farming experience (years)
- X_5 = Level of education (years)
- X_6 = Extension contact (number of visits)
- X_7 = Household size (numbers)
- X_8 = Level of rainfall (high = 1, low = 0)
- X_9 = Level of temperature (high = 1, low = 0)
- β_0 = Intercept
- e_i = Error term

RESULTS AND DISCUSSION

Table 1: Climate Change Incidences Reported by Plantain Farmers

Climate Change Incidences	Strongly Agreed (4)	Agreed (3)	Disagreed (2)	Strongly Disagreed (1)	Mean
Excessive rainfall pattern	70 (58.3%)	6 (5.0%)	29 (24.2%)	15 (12.5%)	3.24
Rising temperature	22 (18.3%)	53 (44.2%)	33 (27.5%)	12 (10.0%)	2.71
Excessive flooding	60 (50.0%)	50 (41.6%)	4 (3.3%)	6 (5.0%)	3.55
Late maturity	56 (46.7%)	54 (45.0%)	6 (5.0%)	4 (3.3%)	3.35
Proliferation of pests and diseases	86 (71.7%)	25 (20.8%)	3 (2.5%)	6 (5.0%)	3.59
Low yield of plantain	95 (79.2%)	7 (5.8%)	11 (9.2%)	7 (5.8%)	3.58
Excessive dryness of the soil	70 (58.3%)	24 (20.0%)	11 (9.2%)	15 (12.5%)	2.24

Note: Values in brackets are percentages. Benchmark Mean = 2.5.

Source: Field Survey, 2025.

Results in Table 1 show that 7 incidence statements were listed and investigated using a benchmark mean score of 2.5. Results showed that 6 out of 7 items had a mean score of 2.5 and above. This implied high incidences of climate change, while only one was considered a non-incidence (excessive dryness of the soil, with a mean of 2.24). The main incidences were rising temperatures (2.71), excessive rainfall (3.24), excessive flooding (3.55), late maturity of crops (3.35), proliferation of diseases (3.59), and low yield (3.58). This finding is in line with the climate change principles outlined by UNEP (2018), NASA (2024), and ECCC (2024).

Table 2: Adaptation Strategies to Climate Change Incidences on Plantain Production

Adaptation Strategies	Strongly Agreed (4)	Agreed (3)	Disagreed (2)	Strongly Disagreed (1)	Mean
Use of drought-tolerant practices	65 (54.2%)	28 (23.3%)	22 (18.3%)	5 (4.2%)	3.3
Disease-resistant plantain varieties	67 (55.8%)	23 (19.2%)	20 (16.7%)	10 (8.3%)	3.1
Incorporation of agroforestry systems	18 (15.0%)	62 (51.7%)	27 (20.8%)	15 (12.5%)	2.7
Adoption of drip irrigation	22 (18.3%)	38 (31.7%)	45 (37.5%)	15 (12.5%)	2.6
Rainwater harvesting systems	56 (46.7%)	24 (20.0%)	25 (20.8%)	18 (15.0%)	3
Construction of drainage channels	54 (45.0%)	26 (21.7%)	28 (23.3%)	12 (10.0%)	3
Use of compost and organic manure	66 (55.0%)	34 (28.3%)	18 (15.0%)	2 (1.7%)	3.4
Implementation of	55 (45.8%)	25	28 (23.3%)	12 (10.0%)	3

mulching		(20.8%)			
Cover cropping	72 (60.0%)	28 (23.3%)	15 (12.5%)	5 (4.2%)	3.4
Contour farming	66 (55.0%)	24 (20.0%)	22 (18.3%)	8 (6.7%)	3.2
Regular monitoring & early detection	63 (52.5%)	27 (22.5%)	18 (15.0%)	12 (10.0%)	3.2
Diversification of livelihood/crops	18 (15.0%)	63 (52.5%)	27 (22.5%)	12 (10.0%)	2.7
Training farmers on climate resilience	27 (22.5%)	18 (15.0%)	63 (52.5%)	12 (10.0%)	2.5
Early warning systems	18 (15.0%)	27 (22.5%)	63 (52.5%)	12 (10.0%)	2.4
Extension networks for information	28 (23.3%)	15 (12.5%)	72 (60.0%)	5 (4.2%)	2.6
Access to climate info & technology	18 (15.0%)	27 (22.5%)	63 (52.5%)	12 (10.0%)	2.4

Source: Field Survey, 2025.

Adaptation Strategies to Climate Change by Plantain Farmers

The distribution of plantain farmers according to their adaptation strategies is presented in Table 2. The data indicated that the adaptation strategies often focused on the specific varieties of plantain grown by farmers in the study area.

The adaptation strategies with the highest mean scores were the use of compost and organic manure (3.4), cover cropping (3.4), use of drought-tolerant varieties (3.3), contour farming (3.2), and regular monitoring and early detection of pests (3.2). Data in the table also indicated that certain items had mean scores less than the benchmark of 2.5. They were early warning systems (2.4) and access to climate information/technology (2.4). The utilization of various adaptation strategies indicates that plantain is one of the major food crops in the study area, and farmers need adequate knowledge on how to improve their yield. This finding aligns with the assertions of the IPCC (2024, 2025) regarding climate change principles.

Table 3: Relationship Between Farmers' Climate Change Incidences and Determinants of Adaptation Strategies

Explanatory variables	Linear	Semi-log	Double-log	Exponential
Constant	229.034	87.165	143.408	102.559
Global rising temperature (X_1)	70.316 (1.953)*	3.094 (1.388)	0.075 (3.912)***	0.006 (2.714)***
Intensity of extreme weather (X_2)	12.007 (1.668)	4.117 (2.542)	0.64 (2.916)	0.009 (2.543)
Energy consumption (X_3)	10.827 (1.385)	3.529 (1.416)	0.046 (1.529)	0.003 (1.702)
Increased transportation (X_4)	11.209 (1.822)	2.802 (1.713)	0.052 (3.673)	0.006 (2.912)
Soil degradation (X_5)	10.116 (1.911)	3.417 (1.882)	3.085 (3.112)	0.007 (1.613)

Changing rainfall pattern (X_6)	13.065 (2.557)	0.044 (2.915)	0.005 (1.802)	4.726 (1.903)
Income level of farmers (X_8)	-10.244 (-1.642)	-3.008 (1.716)	-0.039 (-1.416)	-0.008 (-1.553)
Educational level (X_{10})	11.333 (1.564)	2.908 (1.656)	0.046 (1.829)	0.007 (1.418)
Farm size (X_{11})	14.592 (2.914)	3.115 (1.777)	0.066 (4.169)	0.008 (3.413)
Social network (X_{12})	10.827 (-2.668)	-4.089 (-1.365)	-0.091 (-3.094)	-0.006 (-2.556)
Access to climate change info (X_{13})	11.387 (1.514)	2.692 (1.409)	0.053 (1.316)	0.007 (1.811)
Access to extension services (X_{14})	12.464 (1.391)	3.547 (1.825)	0.081 (1.922)	0.004 (1.397)
Cultural belief (X_{15})	133.829 (1.698)	4.663 (1.742)	0.055 (1.613)	0.009 (1.814)
R^2	0.4938	0.4125	0.7628	0.6123
F-Value	21.9467	16.1765	73.7005	36.1239
Sample size (n)	120	120	120	120

Source: Field Survey, 2025.

Regression Analysis Results

This hypothesis was tested using the t-ratios produced by the multiple regression analysis. The best model was selected based on the highest value of the coefficient of multiple determination (R^2), the highest number of significant variables, and conformity to a priori expectations.

The results of the four functional forms of the multiple regression analysis are presented in Table 3. The results showed that the double-log function produced the highest R^2 value, the highest number of significant variables, and conformed to a priori expectations. The double-log function was therefore chosen as the lead equation.

The R^2 value of 0.76 indicates that 76.3% of the determinants of climate change adaptation strategies are explained by the independent variables. The F-value was highly significant at the 1% level of probability, indicating a regression of best fit. The result of the regression analyses showed that the coefficients for global rising temperatures (X_1), intensity of extreme weather events (X_2), income level (X_8), educational level (X_{10}), and access to climate change information (X_{13}) were positively signed and highly significant. This implies that an increase in income and education leads to better adaptation to climate change, which results in a positive impact on the yield of plantain in the study area. Ebe et al. (2021), NASA (2024), and NEST (2022) obtained a similar result regarding the perceived effects of climate variability.

Conversely, the coefficients for social network (X_{12}) and changing rainfall patterns (X_6) were negatively signed. Therefore, the null hypothesis is hereby rejected with respect to the significant variables and accepted with respect to the non-significant variables.

CONCLUSION

The researchers found that the determinants of climate change adaptation strategies affected plantain production, although the adaptation strategies for climate change were heavily determined by the socio-economic and environmental factors of the farmers. The study recommends that effective policies to improve the adaptation strategies of the farmers should be put in place. Furthermore, governments should encourage plantain production by providing climate change-tolerant varieties and monetary incentives to support farmers.

Article Publication Details

This article is published in the **RGA Global Journal of Multidisciplinary Research**, ISSN XXXX-XXXX (Online). In Volume 1 (2026), Issue 1 (January - February)

The journal is published and managed by **RGA Research Publications**.

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