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Climate Change and Vegetable Farming in Anambra State: Risks and Resilience

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ABSTRACT

Systems for producing vegetables are seriously threatened by climate change, especially in areas where agriculture is a vital source of income. The purpose of this study was to assess farmers' adaptation tactics and examine how climate change is affecting vegetable production in Anambra State, Nigeria. A semi-structured questionnaire was used to gather primary data from 128 vegetable farmers in four villages that produce bitter and fragrant leaves. To address the study's goals, a 4-point Likert scale, Ordinary Least square regression analysis, and descriptive statistics were used. The results showed that the majority of farmers in the study area were married women with one to ten years of farming experience and a secondary degree. The annual income of vegetable producers was greatly impacted by socioeconomic factors, including the area of the cropland and educational attainment. Unsuitable soil conditions, poorer farm revenues, decreased yields, and water scarcity were among the negative effects of climate change that were thought to exist. Zero or minimal tillage, less fertilizer, organic manure application, better irrigation systems, controlled bush burning, ridge construction, mechanical insect control, and vegetable processing were among the adaptation techniques farmers used. The study underlines the need for focused interventions to improve farmers' adaptation capacity and guarantee the sustainability of this vital industry while highlighting the susceptibility of vegetable production systems to the effects of climate change.

INTRODUCTION

Vegetables face environmental challenges such as high temperatures, soil moisture stress, and CO_2 fluctuations, leading to crop failures, reduced yields, quality decline, and increased pest issues, making farming less profitable. By providing essential plant-based proteins, carbohydrates, and vitamins needed for basic nutrition, the vegetable industry remains a vital part of agriculture that supports human life. Its impact on human well-being highlights its importance. However, as the Intergovernmental Panel on Climate Change (IPCC, 2014) notes, it faces significant challenges mainly due to climate change. Climate change, as defined by IPCC (2012), is a sustained pattern of recurring changes in weather parameters such as temperature, pressure, humidity, wind direction and speed, precipitation, and cloud cover that lasts at least 30 years. It can also be described as any consistent, long-term shift in the statistics of climate variables like temperature, precipitation, or wind that persists for several decades or more (Akah et al, 2023). Climate change results from the Earth's inability to absorb pollutants from the activities of our global economy (Enete et al., 2014).

Changes in precipitation patterns create major challenges for agriculture, affecting important crops like fragrance and bitter leaves. From this, it is clear that producers of bitter and fragrant leaves, especially in

developing countries like Nigeria, face severe consequences of climate change. The IPCC's mention of shifting precipitation patterns is particularly relevant because it brings various difficulties, including changes in temperature, precipitation, humidity, pressure, and cloud cover. These changes can lead to seasonal variations, water scarcity, soil erosion, and increased vulnerability to pests and diseases (Trenberth, 2011). All of these factors significantly impact the country's vegetable production, which directly affects the income of farmers who rely on these crops for their livelihoods.

Bitter leaf (Vernonia amygdalina) and scent leaf (Ocimum gratissimum) are two leafy, perennial, and very profitable vegetables that were used in this study. Bitter leaves are members of the Asteraceae family. It is grown as a dietary supplement in West Africa, particularly Nigeria, and is widely dispersed throughout tropical Africa (Balakrishnan et al., 2018). The bitter leaf plant's leaves are used in both cooking and medicine. Although they are frequently used to make soups and decorate food, other plant components have therapeutic uses. Vitamins A, B1, and B2, which are critical for the body, are very abundant in bitter leaf (Mefo et al., 2023). According to Dias (2012), the export of bitter leaf leaves from Anambra State to Europe is an intriguing phenomenon. Many farmers are now interested in growing bitter leaves as a result of this exportation. The market value of bitter leaf helps the Anambra State Government generate cash, demonstrating the economic significance (Dias, 2012).

Scent leaf (Ocimum gratissimum) is a fully grown blooming plant that may be cultivated from seed or cuttings (Mbegbu et al., 2021). In Nigeria, it is a common native plant utilized for both medicinal and nutritional uses. With considerable fluctuation, it grows across the tropics and subtropics, but primarily in tropical Africa and India (Rhoda et al, 2015). Scent leaves have significant therapeutic benefits. It is a useful natural medication because of its well-known antibacterial and anti-inflammatory properties.

With detrimental effects on the environment, human health, agriculture, and physical infrastructure, climate change poses a major danger to sustainable development in poor nations (Tirivangasi, et al, 2021). All aspects of food accessibility, consumption, and food system stability are predicted to be impacted by climate change (Fact Sheet, 2016). Despite the benefits of growing vegetables in Nigeria, the climatic circumstances that vegetable producers endure receive little to no attention. For instance, the studies by Izucukwu et al (2023), Sanou et al. (2023), Osuji et al. (2023), Akah et al. (2023), Olowoyeye et al. (2023), Anugwa et al. (2022), Achakpa et al. (2019), and Ayanlade et al. (2018) were on general agriculture. However, none was on vegetable production, particularly in Anambra State. It was against this backdrop that this study on the effect of climate change on Anambra State's vegetable production was conducted.

Objectives of the study

The broad objective of the study was to assess the effect of Climate change on vegetable production in Anambra State, Nigeria. Specifically, the study sought to;

i. identify the socioeconomic characteristics of vegetable farmers in the study area.

ii. examine the Socio-economic/institutional factors influencing the output of vegetable production

iii. identify the perceived effects of climate change on vegetable production and

iv. identify the adaptation strategies in response to climate change among vegetable producers in the study area

METHODOLOGY

The study area is Anambra State, Nigeria. With a geographic area of roughly 4,844 km2, Anambra State is located in eastern Nigeria between latitudes 6°20'N and longitudes 7°00'E (Ifeka et al, 2015). 128 vegetable producers from Idemili North and Njikoka L.G.A. were selected using a simple random sampling technique. A semi-structured questionnaire was used to collect primary data, which was then

analyzed using descriptive statistics, the Likert scale approach, and an Ordinary Least Squares (OLS) multiple regression model.

Model Specification

The ordinary least squares multiple regression model was employed in this study.

The model for the regression analysis is specified in the equation below

Where; $Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \beta 8X8 + \mu i$
Y……...Annual vegetable income (#)
$\beta 0$…….is a constant / intercept
$\beta 1\ to\ \beta 8$……estimated parameters
The independent variables are X1 through X8
Where;
X_1.....Sex (0=Male, 1=Female)
X_2.....Marital status (0 = single, 1=married, 2= widowed)
X_3……. Education level (0 = No formal education, 1 = Primary education, 2= Secondary education, 3= Tertiary education)
X_4…….Years of farming experience (in number)
X_5…….Household size(number of persons)
X_6……. Years of vegetable experience (in number)
X_7…….Excessive or low sunshine(per hour)
X_8……Farmland sizes (ha)
$\beta 1\ to\ \beta 8$……estimated parameters
$\boldsymbol{\mu}1$…..error term

Likert scale rating technique

Using a 4-point Likert scale rating technique, the responders' mean score was 2.5. In the study, any mean above 2.5 was regarded as a significant effect of climate change, and any mean below 2.5 was seen as not significant.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents.

Table 1 presents the results of the socioeconomic characteristics of the respondents. According to the results, the majority of vegetable growers were women (67.2%), married (62.5%), and had only completed secondary school (50%). The majority of them had a household size of 1-6 (68.6%), had been farmers for 1–10 years (59.4%), and had farming as their primary vocation (81.3%). These female farmers earn between 101,000 and 500,000 (60.9%) per year, and their field size ranges from 0.065-0.50 ha (84.2%). According to the result, mixed cropping accounts for 81.3% of the vegetable production system.

Table 1: Socio-economic characteristics of the respondents

Socio-economic characteristics	Frequency	Percentage	Mean
Sex			
Male	42	32.8	
Female	86	67.2	
Total	128	100	
Religion			
Christianity	122	95.2	
Islam	0	0	
Traditional	6	4.8	
Total	128	100	
Marital status			
Single	38	29.7	
Married	80	62.5	
Divorced	6	4.7	
Widowed	4	3.1	
Total	128	100	
Level of education			
No formal education	8	6.2	
Primary education	30	23.5	
Secondary education	64	50.0	
Tertiary education	26	20.3	
Total	128	100	
Years of farming experience			
1-10	76	59.4	
11-20	42	32.8	
21-30	10	7.8	10.64
31-40	0	0	
Total	128	100	
Major occupation			
Farming	104	81.3	
Trading	24	18.7	
Civil service	0	0	
Others	0	0	
Total	128	100	
Household size			
1-5	88	68.6	
6-10	40	31.2	
11-15	0	0	4.72
Total	128	100	
Years of producing vegetables			
1-10	98	76.6	
11-20	24	18.8	
21-30	6	4.7	
31-40	0	0	7.73
Total	128	100	

Size of farmland in hectares	108	84.2	
0.065-0.50	14	11	
0.51-1	2	1.6	
>1-5	0	0	0.74
6-10	4	3.2	
11-15	128	100	
Total			
Annual vegetable income	10	7.8	
50,000-100,000	78	60.9	
101,000-500,000	30	20.3	1183906.25
501,000-1,000,000	10	6.3	
>1,000,000-5,000,000	0	4.7	
Above 5,000,000	128	100	
Total			
System of vegetable production			
Sole cropping	24	18.8	
Mixed	104	81.3	
Total	128	100	

Source: Field survey, 2024

Socio-economic/institutional factors influencing the output of vegetable production.

The results of the factors affecting the yearly output from vegetable production are displayed in Table 2 below. A 5% probability level was applied to multiple linear regressions. The results indicated that the two main elements influencing the yearly revenue from vegetable production in the research area were the size of the farmland and the level of education. Annual income and the farmers' educational attainment were positively correlated, meaning that the more educated the farmers, the greater their income. This is consistent with the a priori expectation that a farmer's revenue will rise in tandem with his educational attainment. In support of this conclusion, a study by Nurhayani et al. (2022) on the variables influencing the income level of cassava farmers discovered that one of the elements influencing the farmers' income level was their degree of education. Additionally, the data demonstrate that the amount of farmland in the study area significantly affects the farmers' income. Additionally, this is consistent with a priori expectations. Any farmer's income level will rise in proportion to the area of their farmland. The alternative hypothesis was accepted in light of the results, while the null hypothesis—which holds that socioeconomic and institutional factors have no discernible impact on the yearly revenue of vegetable farmers—was rejected. While marital status, years of farming experience, years of vegetable production experience, and too much or too little sunshine had a negative relationship with the dependent variable, other factors like the farmers' sex and household size also had a positive relationship.

The perceived effects of climate change on vegetable production

The perceived effects of climate change on vegetable output in the research area are displayed in Table 3. The most perceived effects were increased pest and disease attacks (2.5156). Ayanlade et al. (2020) also observed increased pest infestation in vegetable farms due to warmer temperatures and humid conditions in southwestern Nigeria. Secondly, washing away of the topsoil (2.8906) was observed, and it aligns with Okonya et al. (2020), whose study identified that increased rainfall intensity leads to erosion and loss of fertile topsoil in vegetable-producing areas. The third effect is Seasonal variation in the production of vegetables (3.4063). This aligns with Tambo & Wünscher (2021), who found that erratic rainfall and changing seasonal patterns disrupted vegetable production cycles in West Africa, including Nigeria. Finally, Post-harvest loss of vegetables (3.0781) was identified, and this was in line with Onyeneke et al.

(2021), who noted that high ambient temperatures and unpredictable rainfall accelerate spoilage of perishable produce like vegetables.

Table 2: Multiple linear regression of variables showing significant coefficients

Model	B	Std.Error	Beta	T	Sig
(Constant)	-627923.242	996658.571		-.630	.531
Sex	66807.125	226297.070	.007	.295	.769
Marital status	-6423.156	155348.230	-.001	-.041	.967
Level of education	180070.709	164878.018	.031	1.092	.028**
Years of farming experience	-6468.328	33151.719	-.009	-.195	.846
Household size	18298.189	50933.266	.008	.359	.721
Years of experience with vegetables	-4209.640	36655.886	-.005	-.115	.909
Excessive or low sunshine	-165161.738	542863.011	-.007	-.304	.762
Size of farmland	1853180.900	49240.368	.992	37.635	.000**
Dependent variable: annual income					
$R^2 = 0.977$, Adjusted $R^2 = 0.974$					

*Source: Field survey, 2024. ** indicates significance at a 5% probability level*

Table 3: Perceived effects of climate change on vegetable production

Perceived effects	Mean	Std. Deviation
Increased scarcity of water for production	1.4063	.49501
Increased pest and disease attacks	2.5156	.97577
Washing away the topsoil	2.8906	1.08551
Reduction in the yield of vegetables	1.5000	.61721
Reduction in the income of vegetable producers	1.3594	.57369
Made the soil condition unsuitable for production	2.1719	.91815
Seasonal variation in the production of vegetables	3.4063	.93806
Reduced farm earnings	1.5000	.66667
Post-harvest loss of vegetables	3.0781	1.07356

Source: Field survey, 2024. NB mean cut-off point is 2.5

Adaptation strategies in response to climate change among vegetable producers

The adaptation strategies in response to climate change among vegetable producers in the research area are displayed in Table 4. The result indicates that the use of resistant varieties (3.4375) was significant. This aligns with findings by Okonya et al. (2020), who found that smallholder vegetable farmers in Africa widely adopted drought- and pest-resistant varieties as a major adaptation strategy. This was followed by the use of cover crop (3.2031), which was supported by Sultan et al. (2021), who reported that cover cropping was used by Nigerian vegetable farmers to manage soil moisture and improve soil structure under erratic rainfall. Changing harvesting dates (3.5313) was also a significant adaptation strategy identified in the study area. This was supported by Tambo & Wünscher (2021), whose study noted that adjusting planting and harvesting periods in response to climate signals is one of the most used practices. Finally, proper storage of harvested vegetables (3.0938) was also significant and aligns with Onyeneke et al. (2021), whose study confirmed that farmers increasingly adopt storage innovations to reduce climate-induced postharvest spoilage.

CONCLUSION

The effect of climate change on vegetable production in Anambra State, Nigeria, was examined. The study concludes that the annual income of vegetable farmers in the study area is significantly impacted by socioeconomic characteristics of the farmers. Factors like the size of their farmland and their level of education at a 5% probability level exhibited a positive link with their annual income. The farmers perceived that climate change would affect their production by washing away the topsoil, increasing post-harvest loss of vegetables, increasing pest and disease attack, and variation in the production of vegetables.

RECOMMENDATIONS

The study recommends that the vegetable farmers should be encouraged to plant climate-resilient vegetable varieties that are better suited to the changing climate, such as heat-resistant and drought-tolerant varieties; improve soil fertility management by adding organic matter, like compost and manure, to improve soil structure, water-holding capacity, and nutrient availability; and diversify crop production by growing climate-resilient crops alongside vegetables. Moreover, to improve vegetable producers' ability to adapt, there should be a push for legislative changes and local government assistance, such as subsidized inputs, climate-resilient infrastructure, and easy access to extension services and loans.

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