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Gender Role and Effects on Climate Change Adaptation Practices Among Vegetable Farmers in Delta Central Zone

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ABSTRACT

In this study, we examined the gender role and the effects of climate change adaptation practices on small-scale vegetable farmers in Delta State. Specific objectives were to; estimate the determinants of climate change adaptation strategy; (ii) examine the resilience level of vegetable farmers by gender and analyze the impact of climate change on net farm income of vegetable farmers. A purposive sampling procedure was adopted where Ethiope East, Okpe, and Uvwie local government areas were selected from Delta Central Agricultural Zone. 119 vegetable farmers were selected for the study. In the regression analysis, descriptive statistics and Multinomial and Binary Logistic Regression Model were used to analyze the data collected during this study. Using the likelihood ratio Chi-square value of 68.5722 as a result of the determinant of climate change adaptation practices, the multinomial regression model fits accurately in estimating the determinant of climate change at a 1 percent probability level. As a result of binary logistics regression, the Black Chi was significant at 1 percent. This means that climate change events have affected vegetable farmers' income negatively. This therefore calls for more effort from the government to strengthen the provision of agricultural extension services by improving its climate information system, providing recommended agricultural inputs and training farmers on best agronomic practices to enhance their holistic adaptation to the effect of climate change.

Keywords: *Gender, Climate change, Adaptation practices, Multinomial regression model, Vegetable farmers*

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INTRODUCTION

Gender roles plays a crucial role in shaping the practices for coping with climate change among small-scale vegetable farmers in Delta State, Nigeria. The traditional division of labour and responsibilities between man and women in agricultural households significantly influences how these farmers responds to the challenges posed by a changing climate (Reid, 2019). Understanding the dynamics of gender roles and their impact on climate change adaptation is essential for designing effective and inclusive strategies to enhance the resilience of these farmers and their agricultural practices in the face of a warming world. This introduction sets the stage for a comprehensive exploration of this critical issues (Bentley *et al*., 2019).

The decision-making processes related to climate change that directly affect their lives are marginalized and excluded (Enwa, 2022). Gender relations in Nigerian agricultural sector have systematically subordinated women, limiting their access to adaptation information and supports (Enwa & Ewuzie, 2023), The concept of gender is defined as a societal creation that highlights the differentiation in responsibilities and possibilities linked to the male and female genders, as well as the social connections between them. Research conducted on the adaptation of farmers in Nigeria to climate change has revealed that gender dynamics and the exclusion of women from climate-related decision-making processes have a negative impact on efforts to adapt to climate change (Sarah & Achoja, 2023). This is particularly significant considering that women contribute to 60-80% of food production in the country, primarily for household consumption (Enete, 2014). However, the underlying institutional factors contributing to these gender-related challenges in Nigeria have yet to be thoroughly explored in existing literature. This gap in literature is what this study intends to fill. Paying attention to these relations is at the core of framing adaptation strategy that will allow farm households build resilience to the impact of climate change in agriculture

As well as these factors, mountain range orientation towards prevailing winds and ocean current, as well as continentally or continental effects are also important (Carr & Thompson, 2014; Opiyo *et al*., 2016).

FAO (2019), Climate change threatens not just the environment but also poverty alleviation, disease prevention, and hunger eradication. This is primarily attributed to the direct and indirect effects of climate change on agricultural productivity. While efforts are being made to address the root causes of climate change through mitigation strategies, it is crucial to prioritize the development of adaptive capacity. Enhancing adaptive capacity is essential in effectively addressing both the present and future impacts of climate change.

Eneji *et al.* (2017) Viewed Climate change, commonly known as climate change, has significantly affected all aspects of agricultural production in the past few decades. Given their richness in micro-nutrient content and the increased knowledge of healthy eating among people in recent times, vegetables are now regarded universally as a crucial source of nourishment for

humans. Given that vegetable output has expanded dramatically over the past 250 years and that vegetables now have a higher worldwide trade value than cereals, farmers can potentially raise their revenue through its cultivation. As of 2020, Fadairo *et al*. (2020) On the other hand, poor soil moisture and high temperatures are known to have a negative impact on vegetable production, leading to low yields (Williams *et al*., 2017; Williams *et al*., 2018). Climate change have emerged as a major problem of agriculture transformation in sub-Saharan Africa with increasing experiences of unpredictable and erratic rainfall and severe temperatures threatening rural livelihoods and food security in Nigeria (Ofuoku & Ogisi, 2020).

Mkonda *et al*. (2018). In contrast, climate change awareness involves all information, abilities, and strategies involved in reducing climate variability's effects. It is anticipated that vegetable farmers will implement adaptation strategies to manage the risks associated with climate change and their productive endeavors in order to achieve a sustainable level of output (Ojo & Baiyegunhi, 2020; Kumar *et al*., 2021). Farmers have access to a range of adaptation techniques, and how they employ them will depend on their perception of climate change (Hasan & Kumar, 2019). This is according to Stringer *et al*. (2020) and Ojo and Baiyegunhi, (2020). Conversely, some of these strategies for climate change adaptation are exclusive to a given area. Understanding the location of the Delta Central agricultural zone is crucial because the different effects of climate change on vegetable production directly influence decisions that affect output and net revenue accruable to farming firms (Pandey *et al.*, 2018).

specific drivers of adaptation to climate change among smallho lder vegetable farmers in the Extant studies that examined the link between agricultural productivity and climate change adaptation practices (Kurukulasuriya *et al*., 2006; Di Falco *et al*., 2012), and those that examine the impact of climate change on net farm income (Ojo & Baiyegunhi, 2020), Thinda *et al*. (2020), and others focusing on the factors influencing the adoption of climate change adaptation strategies, there are a number of ways that adaptation can be supported through the provision of institutional factors. According to the theory put forth by Asrat and Simane (2018), farmers must first recognize how climate change is affecting their productivity before taking appropriate action to adapt. A number of studies have also looked into how crop yields are affected by climate change (Ajetomobi *et al*., 2010; Huong *et al*., 2018; Madaki *et al.*, 2023) on climate change adaptation strategies determinants and farmers' perception of climate change (Singh, 2019). However, little research has been done on how gender roles and methods for coping with climate change interact to affect Nigerian small-scale vegetable farmers' net farm revenue. The overarching research questions of this study are-what determines the climate change impact on small scale vegetable farmers; what are resilience level of vegetable farmers by gender and what is the impact of climate change on their net farm income? The objectives of the study, therefore were to; estimate the determinants of climate change adaptation strategy; (ii) examine the resilience level of vegetable farmers by gender and analyze the impact of climate change on net farm income of vegetable farmers. This is imperative as the actual climate change communication and policy, therefore, require a good understanding of smallholders' views and acknowledgment of individual's perception about climate change (FAO, 2019). Vegetable farmer's net farm income under climate change scenarios as a sensitivity analysis. This study is thus expected to contribute to the economic impact of vegetable production in the context of climate change in the study area (Enwa *et al.,* 2024).

MATERIALS AND METHODS

Using a purposive sampling procedure, Ethiope East, Okpe and Uvwie local government areas were selected from Delta Central Agricultural Zone. Selection ensures that each farmer grows vegetables using pumpkins, peppers, water leaves, soko (shoko) tomatoes, okro, scent leaves, water leaves, bitter leaves, etc. This procedure was used because a particular type of vegetable farmer was very few in number, leading to the selection process being used. The information collected includes the socioeconomic characteristics, determinant of climate change adaptation strategies, resilience and impact of climate change on net income of small scale vegetable farmers. A similar method was adopted by Ayyogari *et al*. (2014), where male and female vegetable farmers were selected in Punjab. Another study was conducted by Adeagbo and Adetoro (2021) in south Western Nigeria where maize and rice farmers where paired in the study. Data for this study was generated using the effects on climate change adaptation methods among small-scale vegetable farmers: a questionnaire and a personal interview were the two sets of instruments used. The researchers manually collected, coded, and analyzed the instruments in each of the three (3) local government entities that make up the Delta North Agricultural Zone. Descriptive statistics, Binary Logistics Regression and Multinomial Logistic Regression models were employed to analyze the data for this research.

Model development

Binary logistics regression

Climate change affects smallholder vegetable growers' net farm revenues using binary logistic regression.

The explicit representation of the logistic model looks like this:

$$Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + U \quad (1)$$

Where P = the likelihood of being affected by climate change; 1-P = the likelihood of not being affected by climate change

β_0 = Intercept

β_1 = Regression Coefficient of the independent variable

U = error term.

Multinomial logistic regression model

To estimate the main determinants of climate change adaptation strategies, multinomial logistic regression was used. The model is expressed as:

$$\log(Adaptation\ Strategies) = \frac{\exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_7 X_7\right)}{1 + \sum_{j=1}^{Adpt.Strategies_j - 1} \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_7 X_7)} + e_i \quad (2)$$

Where:
Adaptation Strategies = Changing location = 1; Building new flood structure = 2; Planting of cover crops = 3; Insurance = 4
X_1 = Gender (dummy: male = 1; female 0)
X_2 = Number of years schooling (years)
X_3 = Family size (number of persons in a household)
X_4 = Farm size (hectares)
X_5 = Are you aware of any climate change adaptation practices (dummy: yes =1; no = 2)
X_6 = Membership of an association (dummy: yes =1; no = 2)
X_7 = If yes what type of disaster (flooding = 1; precipitation = 2; high temperature = 3; humidity = 4; wind = 5)
β_0 = Intercept
β_1 = Regression Coefficient of the independent variable
e_i = error term

The study conducted by Oluwatayo and Ojo (2016) in Oyo state regarding the climate change adaptation among yam based farmers adopted the Logistics Regression Model to analyze data collected during their study. Also Mohammed *et al*. (2020), conducted a research on the determinant of climate change adaptation strategies among farmers in Borno State Nigeria where they adopted the Multinomial Logistics Regression Model to analyze the data. The study will as adopt these models in order to show the impact of climate change variables and how it has affected vegetable farmers in the area.

RESULTS AND DISCUSSION

Table 1. Socioeconomic characteristics

Variable	Frequency	Percent	Mean/Mode
Gender			
Male	35	29.7	Female
Female	83	70.3	
Number of years schooling			
1-3	8	6.8	9 years
4-6	45	38.1	
7-9	58	49.2	
10-12	1	0.8	
13-15	6	5.1	
Education			
No formal education	13	11.0	
Primary	40	33.9	
Secondary	59	50.0	Secondary
HND BSC	6	5.1	
Family size			
1-3	21	17.8	
4-6	66	55.9	7persons
7-9	28	23.7	
10-12	3	2.5	
Farm size			
1-3	88	74.6	3hectres s
4-6	21	17.8	
7-9	7	5.9	
10-12	2	1.7	
Type of vegetable cultivated			
Pumpkin	29	24.6	
Tomatoes	8	6.8	
Okra	37	31.4	Okra
Pepper	5	4.2	
Water leaves	6	5.1	
Soko	24	20.3	
Bitter leaves	6	5.1	
Scent leaves	3	2.5	
Have you been affected by climate disaster?			
Yes	88	74.6	Yes

No	30	25.4	
If yes, what type of disaster			
High temperature	15	12.7	
Flooding	39	33.1	Flooding
Precipitation	21	17.8	
Humidity	28	23.7	
Wind	15	12.7	
Are you aware of any climate change adaptation practices?			
Yes	56	47.5	
No	62	52.5	No
What type of adaptation strategy do you employ?			
Changing location	69	58.5	Changing location
Building new flood structure	4	3.4	
Planting of cover crops	40	33.9	
Insurance	5	4.2	
Are male farmers able to develop more resilience than female farmers?			
Yes	84	71.2	Yes
No	34	28.8	
Does climate change have any impact on your income?			
Yes	93	78.8	Yes
No	25	21.2	
Income level before the climate change disaster			
0 - 99,999	15	12.7	
100,000 - 199,999	25	21.2	143,898.3
200,000 - 299,999	29	24.6	
300,000 - 399,999	11	9.3	
400,000 - 499,999	16	13.6	
500,000 - 599,999	7	5.9	
600,000 and above	15	12.7	
Income level after the climate change disaster			
0 - 99,999	106	89.8	47,177.9
100,000 - 199,999	11	9.3	
200,000 - 299,999	0	0.0	
300,000 - 399,999	0	0.0	
400,000 - 499,999	0	0.0	
500,000 - 599,999	0	0.0	
600,000 and above	1	0.8	
Membership of an association			
Yes	65	55.1	Yes
No	53	44.9	

Table 1 showed the result of the descriptive statistics indicating that 70.3% of vegetable farmers in the study area were female while only about 29.7% of them were male, this implies that the female folks are more involved in vegetable farming than their male counterparts. This might be a result of the fact that vegetable cultivation is a feminine job and it might not be as tedious and tasking as cassava or yam cultivation in some cases. Similar studies were conducted by Ugwuja and Onwuachu (2020) in Anambra; Ani *et al*. (2021), Enugu state respectively, where female respondents outnumbered their male counterparts in small-scale crop farming. The study also revealed that the majority (50.0%) of the vegetable farmers had secondary school certification. This report is related to the work carried out by Ayinde *et al*. (2020). The result on **Table 1** also showed that the outcome of this is that farmers are better equipped to withstand the negative effects of climate change on local vegetable production (Onyeneke *et al*., 2021). With an average household size of about seven people, vegetable farmers likely had a sizable family. Some of these farmers may have been relatives or long-term dependents, which would have helped with vegetable production and adaptation to the local climate. The findings of Abegunde *et al*. (2019) and Mujeyi *et al*.

(2021) are relevant to this outcome. The average farm size was 3 hectares, which is comparable to rural farmlands, which are typically tiny, dispersed, and fragmented (Abu *et al*., 2018; Anugwa *et al.*, 2022). The mean vegetable cultivated in the area of study was okra, this means that vegetable farmers in the study area cultivated more okra probably due to the resilient nature of okra plants to climate impact such as flooding, relative humidity, high temperature, etc. Other vegetables such as tomatoes, pumpkin, water leaves, pepper, etc. were also cultivated by other smallholder farmers in the study. In harmony with the investigation carried out by Onyeneke *et al*. (2021), where they found that smallholder tomato farmers in Nigeria embraced the planting of cover crops as a mitigative strategy to climate change impact on their farms. This research work also revealed that a lot of cultivators of vegetable crops suffered from the devastating impact of flooding destroying and damaging their farms. Studies (Olayide *et al*., 2016; Durodola, 2019) have shown that flooding has been a serious climate change disaster affecting the majority of smallholder farmers in Nigeria. the mean income of vegetable farmers before any climate change impact was 143,898.3 while during the climate change disaster, their mean income was drastically reduced to as low as 47,177.9. this suggests that for vegetables in the research region, farmers were at risk during climate change impact either flooding, relative humidity, high temperature, wind, or precipitation, farmers are faced with a lot of financial challenges in their farms. A lot of studies (Campbell *et al*., 2015; Tarfa *et al*., 2019; Enwa & Ewuzie 2023) have been carried out to prove that climate change has hurt smallholder farming households. The study also showed that the major climatic event facing and disrupting the production of vegetables in the study area was flooding. Flooding is known to have a devastating impact on agricultural production over time in south-south Nigeria. This study is in agreement with the research work carried out by Ebuzoeme (2015) on the effects of flooding in Awka which found that flooding has been the major climate change variable affecting the smallest-scale farming household in Nigeria.

Table 2. Estimate the determinants of climate change adaptation strategy

CHANGING LOCATION	***Coefficient***	***Std. Error***	***z***	***p-value***
Const.	332.219	7.30815	45.46	<0.0001
Gender	38.1789***	1.75816	21.72	<0.0001
Number of years of schooling	−19.6582***	0.400633	−49.07	<0.0001
Family size	19.2859***	0.528096	36.52	<0.0001
Farm size	−19.9442***	1.05660	−18.88	<0.0001
Are you aware of any climate change adaptation practices	18.4063***	1.67139	11.01	<0.0001
Membership of an association	−136.487***	2.97471	−45.88	<0.0001
If yes what type of disaster	−95.3146***	2.78536	−34.22	<0.0001
BUILDING NEW FLOOD STRUCTURE				
Const.	−0.872204	2.07430	−0.4205	0.6741
Gender	1.68287**	0.681252	2.470	0.0135
Number of years of schooling	−0.119908	0.0826805	−1.450	0.1470
Family size	−0.184189*	0.110457	−1.668	0.0954
Farm size	0.0235981	0.153205	0.1540	0.8776
Are you aware of any climate change adaptation practices	0.142179	0.502935	0.2827	0.7774
Membership of an association	0.476134	0.549413	0.8666	0.3861
If yes what type of disaster	0.0259003	0.220501	0.1175	0.9065
PLANTING OF COVER CROPS				
Const.	−31.5669	5.43804	−5.805	<0.0001
Gender	24.4673***	0.513896	47.61	<0.0001
Number of years of schooling	0.222064	0.144581	1.536	0.1246
Family size	−0.309148	0.281598	−1.098	0.2723
Farm size	0.559566***	0.187869	2.978	0.0029
Are you aware of any climate change adaptation practices	1.45521	1.35327	1.075	0.2822
Membership of an association	0.563754	1.20828	0.4666	0.6408
If yes what type of disaster	−0.348263	0.469601	−0.7416	0.4583
Mean dependent var	1.838983	S.D. dependent var		1.037505
Log-likelihood	−75.35378	Akaike criterion		198.7076
Schwarz criterion	265.2040	Hannan-Quinn		225.7071

(source: field survey 2023)
Number of cases 'correctly predicted' = 78 (66.1%)
Likelihood ratio test: Chi-square (21) = 68.5722 [0.0000]

The results of the determinants of practices for adapting to climate change are shown in **Table 2**. The multinomial regression result of the factors influencing the research area's adaptation strategies to change in climate was displayed in this study. At the one percent probability level, the likelihood ratio Chi-square value of 68.5722 was significant, indicating that the multinomial regression model fitted correctly in calculating the determinant of climate change adaptation events in the studied

area. Therefore, there is a significant effect of the socio-economic characteristics of the farmers on adaptation strategies in Delta Central Agricultural Zone, Nigeria. This study also revealed that gender was a determining factor in climate change adaptation strategy. The level of education of farmers had a significant relationship (negative) with climate change adaptation practices (Building new flood structures, changing location, insurance, planting of cover crops), (Ani *et al.*, 2021).

It is implied that those with higher levels of education are more likely than those with lower levels of education to be aware of climate change. People with more education are more aware of their surroundings and are better able to detect climatic changes (Etana *et al*., 2020). This suggests further that farmers' responses to climate change events are influenced by their level of knowledge. Farmers with higher educational attainment are more equipped to handle climate events like high temperatures, precipitation, wind, flooding, humidity, etc. through adaptation strategies, comprehension, and knowledge base. One important factor in helping farmers overcome the terrible experiences of climate catastrophes is education (Olutegbe & Fadairo, 2016). Changing location during flooding or other climate change events was significantly positively correlated with the farmers' family size. It follows from this that a key factor influencing adaption strategies is household size. It means that a farmer is more likely to adopt techniques that will lessen the impact of climate change events if his or her household is larger. This is probably due to the larger home size and the fact that every family member who lives there may see and document any changes in the weather. Large home sizes are seen to be a contributing factor to family labor, which could be used to control climate-related disasters. By Sarah and Achoja (2023).

Table 3. Resilience level of vegetable farmers by gender

Variable	Frequency	Percent	Mode
Male	84	71.2	Male
Female	34	28.8	

(Source: field survey 2023)

The result showing the resilience level of vegetable farmers by gender is presented in **Table 3**. The result of this study revealed that male vegetable farmers are more resilient to climate change events than their female counterparts. A similar study was conducted by Atube *et al.* (2021) and found that the male crop farmers in Uganda are more resilient to climate change events than the female crop farmers. This could be a result of the fact that the male farmers were breadwinners of the family and were willing to go to any extent to protect their source of livelihood. When it came to installing cover crops, constructing a new flood structure, and relocating to dry areas, gender had a favorable and considerable impact. This demonstrates that factors influencing vegetable growers' strategies for adapting to climate change are gender-neutral. The positive significant relationship with the building of new flood structures, changing location, and planting of cover crops implies that male vegetable farmers developed more resilience to climate change events than female vegetable farmers. This could be probably because male farmers are willing to take risks or do what it takes to prevent their farms from being destroyed by climate change disasters (Heeb *et al*., 2019).

Effects of change in climate on net farm income of smallholder vegetable farmers

Model 8: Logit, using observations 1-118
Dependent variable: have you been affected by climate disaster?
QML standard errors

Table 4. Influence of Climate Change of Net Farm Revenue of Vegetable Growers

	Coefficient	*Std. Error*	*Z*	*p-value*
Const.	−1.14313e-07	1.79954e-06	−0.06352	0.9493
Income level after the climate change	-1.08155***	0.227632	-4.751	<0.0001
Mean dependent var	0.745763	S.D. dependent var		0.437288
McFadden R-squared	0.516524	Adjusted R-squared		0.398801
Log-likelihood	−66.89821	Akaike criterion		137.7964
Schwarz criterion	143.3378	Hannan-Quinn		140.0464

Number of cases 'correctly predicted' = 88 (74.6%)
f(beta'x) at mean of independent vars = 0.437
Likelihood ratio test: Chi-square(1) = 40.31565 [0.0000]

The influence of climate change on the net farm revenue of vegetable growers was evaluated using binary logistic regression analysis. The result of the influence of climate change on net farm income of vegetable farmers is presented on **Table 4**.

According to post-estimation findings, the significance level for the Schwarz Chi was 1 percent.

This suggests that smallholder vegetable growers' net farm revenue was significantly impacted by climate change events.

This indicates that the event of climate change hurts the income of vegetable farmers.

A few of the explanatory variables in the study area had an impact on the net farm income of smallholder farmers, according to the binary logistics regression results. In a related study, Branch (2018) discovered that the drought caused by climate change had a significant impact on the income of rural agricultural households in northern Uganda.

CONCLUSION

In this research, we assessed gender roles and the effects of climate change on the adaptation practices of small-scale vegetable farmers in Delta State. Using 119 small-scale vegetable farmers across 3 local government areas of Delta Central agricultural zone. Using the study sample size, it was noticed that respondents' gender, and level of education determined their approaches to embracing improved climate change mitigation techniques for small-scale vegetable growers. Most of the respondents who went ahead to build new flood structures and planting of cover crops were more literate than less educated farmers. This research work also revealed that

majority of the vegetable farmers suffered from the devastating impact of flooding destroying and damaging their farms. The study also revealed that male vegetable farmers are more resilient to climate change events than the female vegetable farmers in the study area. Using the binary logistics regression analysis, climate change disaster hurt the net farm income of vegetable farmers in the study. In light of the aforementioned, the study suggests that government and development partners concentrate on educating farmers about improved production methods and strategies for adapting to climate change through agricultural extension and the media, as well as developing affordable credit schemes through creative means. Small-scale vegetable farmers should also be encouraged to organize into cooperative societies so that government agencies and other organizations dealing with climate change can easily find them and provide them with first-hand knowledge about climate change and how to mitigate its effects on agricultural production.

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