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Adaptation Measures To Climate Change Among Yam Farmers In Delta State, Nigeria

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Abstract: *The study investigates the adaptation measures to climate change among yam farmers in Delta State, Nigeria. Simple random sampling done on multi-stage procedure were used to create a sample size of 540 respondents. Data were generated from Primary sources. The primary data were collected using questionnaire. Reliance on weather forecast and information ($\bar{x}$= 2.6) and irrigation practices ($\bar{x}$= 2.6) were disagreed as adaptation methods to climate change. water logging ($\bar{x}$=3.5), soil salinity ($\bar{x}$=3.4), reduced biodiversity ($\bar{x}$=3.4), crop failure ($\bar{x}$=3.4), yield reduction ($\bar{x}$=3.6), soil erosion ($\bar{x}$=3.4), economic return ($\bar{x}$=3.6) and illness ($\bar{x}$=3.6) were agreed high effects of climate change by the respondents. Constraints to climate change were inadequate political will and commitment ($\bar{x}$= 3.3). Inadequate credit facilities **($\bar{x}$= 3.3).** Poor information delivery on early weather warnings from NIMET ($\bar{x}$= 3.4). Shortage of land ($\bar{x}$= 3.3). climate change has effects in yam production in Delta State, Nigeria. Early warnings about weather from Nigeria Institute of Meteorology (NIMET) to farmers will help farmers plan well on yam production and have good output.*

KEYWORDS: Adaptation measures, climate change, yam farmers, Delta State.

INTRODUCTION

Climate change and extremes events are a major concern for agriculture as crop productions and output exhibit a high degree of variability due to changes in temperature and rainfall. Agricultural productivity is largely determined by climate and climate variability in rainfall and temperature is believed to affect global crop production and yields. Temperature and rainfall are becoming more varied on a daily basis as projections indicate that the trend would continue (Holleman, Rembold, Crespo and Conti, 2020).

Yam yield in Delta State is already experiencing gigantic pressure from weather and climate variability. Rural farmers have poor knowledge regarding weather variability because of climate change as well as its adaptation (Ekemini, Ayanwale and Adelegan, 2019). Local knowledge of climate change causes and adaptation should be made available through all forms of media like outreach visits, field tours, radio, television, newspapers, magazines, seminars, workshops and handbooks in order to facilitate sustainable and equitable agricultural development and productivity among rural farm families in Delta State of Nigeria (Anabaraonye, Chukwuma and Olamire, 2019). Climate change adaptation means actions that reduce the vulnerability to the actual or expected impacts of climate change such as extreme weather/hazards, loss of biodiversity, food and water scarcity, sea level rise.

Climate change adaptation also means broad set of actions to minimize vulnerability to the impacts of climate change. Adaptation measures have been found to reduce the impacts of climate change on crop production, and these include farming of alternative crops, intercropping with other types of crops, crop insurance, water harvesting techniques, early warning systems, monitoring systems, construction of dykes, human migration, changing planting times, diversification in and out of agriculture, reliance on safety net and social networks and sale of assets (Ochiengi *et al*, 2016).

According to Tamalu and Fwkadu (2019), who opined that to reduce the impacts of climate change on crop production and agricultural productivity, adopting and implementing different adaptation measures is pertinent such adaptation measures include: using traditional ecological knowledge, irrigation activities, water harvesting, strong policy, use of advance technology, strong institutional frame work, use of available opportunities, the introduction of stress tolerant varieties of crops.

Climate change adaptation refers to how farmers update their expectations of the climate in response to unusual weather. It is also the adjustment of natural or human systems in response to actual or projected climatic stimuli or their effects, moderating, hurting or exploiting opportunities. Adaptation is a change in behaviour or economic structure and coping ability to shorter term that reduces the exposure of society to climatic system variability. The typologies of adaptation capacity experienced by communities are autonomous or planned adaptation, proactive or reactive adaptation, short or long term adaptation and localized or widespread adaptation response. Also adaptation strategies can be distinguished by the temporal scope, spatial scope and form, proactive and anticipatory adaptation (Azemir *et al*., 2021).

Osuji *et al* (2023) described that adaptation strategies are planting improved varieties, insurance, planting substitute crops, diversification of livelihoods, soil conservation and water conservation practices, irrigation, change in planting and harvesting dates, reliance on weather information and forecast, collaboration with extension workers/agencies, utilization of fertilizer in the proper way, efficient and effective use of pesticides, expansion of access to land and erosion control.

Ogbonna (2019) asserted that mulching as it conserves water, altering date of planting, planting early maturing crops, irrigation, intensification in frequency of weeding, early/punctual harvesting, minimum tillage, diversification of sources of income, efficient conservation of seed, farm shifting/rotation, conservation of water channels as drainage system of water, planting pest and diseases resistant crops, planting drought and heat resistant crop varieties, conservation of the soil moisture through efficient tillage operation are adaptation measures taken by arable crop farmers to reduce the impacts of climate change on agricultural production.

In Delta State Climate change has caused severe flooding and erosion, rise of sea level, seasonal temperature changes, more intensive and frequent storms, more heat waves, irregular rainfall pattern, extreme floods, extreme weather conditions and drought, causing low agricultural output, hunger and poverty as many farms are washed away or waterlogged as well as other extreme events which influence farming activities. Climate change causes food shortages and reduction in supply especially yam in Delta State. Therefore, the objectives of the study are to: i examine the level of usage of adaptation measures to climate change by yam farmers, ii ascertain the effects of climate change to yam farming and iii identify the constraints to climate change adaptation by yam farmers in the study area

METHODOLOGY

The study was carried out in Delta State. The State was formed from the former Bendel State on 27th August 1991. It is located within Longitude 5°00 and 6°45' East and Latitude 5°00 and 6°30' North. Delta State is generally low-lying without remarkable hills. The State has a wide coastal belt inter-lace with rivulets and streams, forming part of the Niger-Delta. Delta state comprises twenty-five (25) Local Government Areas. The State has been divided into three (3) agricultural zones, i.e., Delta North, Delta Central and Delta South. The State has a tropical climate with two pronounced seasons, i.e., dry and rainy season.

Sampling Procedure and Sample Size: A multistage sampling procedure was used to select 540 yam farmers from the three Agricultural zones of Delta state. First, random sampling of 60% of the Local Government Areas (LGAs) in the Three (3) agricultural zones, that gave Five (5) Local Government Areas (LGAs) from Delta North, Delta Central Seven (7) LGAs and Two (2) LGAs was covered in Delta South, making a total of Fourteen (14) LGAs. Secondly, three (3) farming communities were drawn randomly from each of the Fourteen (14) LGAs earlier selected, that gave a total of Forty-Two (42) communities. Subsequently, ten percent (10%) of yam farmers from each of the Forty-Two (42) communities were randomly selected, to compose the sample size. Yam farmers in the selected communities formed the sampling frame.

Method of Data Collection and Data Analysis: Data for this study was generated from Primary sources. The primary data were gathered from yam farmers via questionnaire. Data were analyses using mean and standard deviation values derived from Likert type scaling.

RESULTS AND DISCUSSION

Adaptation Measures

The results in Table 1 presents the level of usage of adaptation measures employed by yam farmers in Delta State to counter the effects of climate change. Reliance on weather forecast and information ($\bar{x}$= 2.61) and irrigation activities ($\bar{x}$= 2.55) were not used by yam farmers as usage of adaptation methods to climate change. **Shifting Planting/Harvesting Dates:** Shifting of planting and harvesting dates ($\bar{x}$ = 3.83), is considered one of the most important adaptation practices. This allows farmers to adjust their time of yam planting activities to changing weather patterns. The result agreed with Ogbonna (2019) and Osuji *et al*. (2023), that flexible planting dates allow for the adaptation and mitigation of risks associated with unforeseen rainfall and increased temperatures lately recorded due to climate change. The chances of crop failure or poor output are minimized for farmers who adopted this approach. **Planting of Early Maturing Varieties:** Early-maturing yam varieties ($\bar{x}$= 3.52) are planted quite often because these allow farmers to harvest before the extreme weather conditions, such as floods and droughts, may arise. The finding is in line with Elijah *et al.* (2020), that early maturing crops are less exposed to climatic-related stresses that have helped in maintaining yam output even during unfavourable climatic conditions. **Early harvesting**: This is another widely adopted adaptation strategy that helps farmers avoid crop damage from extreme weather events ($\bar{x}$= 3.64). The finding is in agreement with Aturamu *et al*. (2021), that early harvesting will avert the loss of crops resulting from sudden changes in weather patterns-such as sudden heavy rainfall or sudden prolonging of the dry spell. **Farm Rotation:** Farm rotation ($\bar{x}$= 3.71) is one adaptation method in which crops are rotated on the same land to maintain soil health. The finding is in tandem with Chukwuone (2015), who demonstrated how crop rotation improves the fertility of the soil while preventing pest infestations aspects that are very important for sustaining yam productivity amidst a changing climate. **Planting Pest and Disease-Resistant Crops:** Planting such varieties of yams which are resistant to pests and diseases ($\bar{x}$=3.62) will be very important in reducing the effects of climate-induced outbreaks of pests and diseases. The finding is in line with Oluwatayo and Ojo (2016), that developing and adopting this type of crop variety is important in ensuring that farmers of yams can keep up high output with rising temperatures and increased pest prevalence. **Planting Drought/Heat-Resistant Crops:** Resilient crops that are drought and heat resistant have an average of ($\bar{x}$=3.54**)**. This helps deal with erratic rainfall and increased temperatures, which is the true characteristic of climate change in Delta State. The finding is in agreement with Aturamu *et al.* (2021), that resilient varieties can withstand harsh weather conditions and guarantee more stable food supplies while reducing farmers' vulnerability to climate shocks. **Minimum Tillage:** The minimum tillage ($\bar{x}$ = 4.12) incorporates methods that reduce the disturbance of the soil and thus is highly adopted by the yam farmers. This is affirmed with Elijah *et al*. (2018), that it helps in retaining soil moisture and improving the structure of the soil, reducing erosion, hence serving as a very viable adaptation strategy in trying to combat the effects of climatic change. **Diversification of livelihoods:** This is one common adaptation strategy ($\bar{x}$= 4.05) as it reduces dependence on yam farming alone. the finding is in agreement with Osuji *et al*. (2023), that households that take up several income activities stand a better chance of withstanding the economic shock posed by crop failures from climate change. **Reliance on Weather Forecast and Information:** Though important, the reliance on weather forecast is below average ($\bar{x}$= 2.61). This is presumably because a majority of farmers do not have access to timely and accurate information. The result is in tandem with Ebenehi *et al*. (2018), that a majority of rural farmers in Nigeria are not capable of getting authentic and reliable weather information that would enable them to make effective decisions regarding planting and harvesting dates. **Irrigation Practices:** The low level of utilization of irrigation systems falls below the average, ($\bar{x}$= 2.55). This is because farmers in Delta State depend totally on rain-fed farming and irrigation is not a common practice in yam production. But is a great concern, especially for regions whose rainfall pattern is irregular. This is supported by Ibrahim (2024) who postulated that improved technological irrigation infrastructure will go a long way in improving agricultural resilience to climate change. However, the high cost and lack of government support for irrigation projects as well as over dependence on rain-fed agriculture in Delta State could explain such a low adoption.

Table 1: Level of usage of adaptation measures in combating effects of climate variability by yam farmers

Measures	Mean	Std. Dev	Remark
Adjustment of planting /harvesting date	3.83	0.829	Usage
Planting early maturing crops	3.52	0.827	Usage
Early harvesting	3.64	0.845	Usage
Farm rotation	3.71	0.865	Usage
Planting pest and disease resistant crops	3.62	0.940	Usage
Planting drought/heat resistant crops	3.54	0.853	Usage
Minimum tillage	4.12	1.007	Usage
Livelihood diversification	4.05	0.883	Usage
Reliance on weather forecast and information	2.61	1.512	Non-usage
Irrigation activities	2.55	1.362	Non-usage

Source**:** Field Survey, 2024. Where**:** A = Adoption**,** T = Trial**,** E = Evaluation**,** I = Interest, A = Awareness**.**

Effects of climate change on yam farming

Table 2 results reviews that insect infestation increase ($\bar{x}$**= 2.**43**),** Food shortage increase ($\bar{x}$**= 2.**42**)** and Reduced soil fertility ($\bar{x}$**=** 2.43) were responded low effects to climate change in the study area. **Water Logging:** High rainfall leading to water logging has one of the highest mean scores at 3.51. This simply reveals that farmers are highly affected by waterlogged fields, thereby causing oxygen starvation to yam roots, giving stunted growth, and often leading to crop failure. High rainfall disrupts the soil's water balance to a condition unfavourable for yam production. This agrees with Ibrahim (2024), who noted that severe weather conditions in the form of high rainfall largely lead to low yam yields due to soil saturation.

Soil Salinity: Soil salinity is another major issue that farmers face in yam cultivation. Its mean response value is 3.42. Climate change enhances salt deposition in the land which yams, because of their sensitivity to salty conditions, are not able to extract the proper requirements and thus tend to lower the yield. This is partly because erratic rainfall, in particular, worsens soil fertility and productivity by building up salts in the soil. This finding agrees with Ozioko *et al.* (2022) and Osuji *et al*. (2023), reported similar occurrences in other root crops like cassava. Climate change is thought to adversely affect their products due to increased salinity of the soil. **Reduced Biodiversity:** A reduced biodiversity mean score of 3.43 indicates the huge impact of climate change on the ecosystem surrounding yam farming. It must be underlined that reduced biodiversity is not only occurring within the case of yam crops but also causes turbulence to ecological balance required for its productivity. These findings also align with those of Ebenehi *et al*. (2018) and Osuji *et al*. (2023), who observed that loss of biodiversity threatens the resilience of crops and long-term agricultural sustainability in creating difficulties for farmers to resist the changing climatic condition. **Crop Failure:** The failure of crops is also one of the major problems faced by yam farmers in Delta State, with a mean score of 3.44. Amuwah *et al*. (2021), that both short-run and long-run fluctuations in climatic conditions have a direct negative impact on yam production and cause crop failure almost every year. **Yield Reduction:** The mean score for yield reduction is 3.61, showing the highest severity of climate change impacts on yam farming in Delta State. Ibrahim 2024 also established the decline in crop yield as one of the most important effects of climate change on yam farmers, further influenced by carbon dioxide levels and unpredictable climatic conditions. **Infestation by Insects:** Infestation by insects, rated 2.41 on average. Although insects and pests are considered to be a problem, the effect is minute compared to the effects on yield reduction and the land becoming waterlogged. Also, chemicals used in controlling weeds have positive effects and yam treatment before planting by some farmers could be the reason for low effects of insect infestation. Elijah *et al*. (2020), that with increased temperature and changing climate conditions, the population of pests increases and tends to increase infestation in the future. **Food Shortage:** The food shortage caused by the change in climate is an average to severe effect, with a mean score of 2.42. If the yam output were decreased, it would be impossible for the community or any other depending on yam as staple food not to go through a food shortage. This consensus agrees with Chukwuone (2015), who also observed that the resultant effect of climate change in reduced crop output acts to directly perpetuate food insecurity among agricultural communities, where farmers fail to produce enough food meant for household consumption and market sales. **Soil Fertility Reduction:** With a mean score of 2.43, reduced soil fertility is a problem of a moderate effects. Osuji *et al*. (2023) noted that soil fertility reduction still remains an important issue due to the fact that root crops, especially yam, need good soil for good output. **Soil Erosion**: This is presented as a considerable problem with a mean score of 3.41 presented by heavy rainfall and deforestation which clears off the topsoil where the fertile portion of the soil lies that yam needs to grow. It affects crop growth negatively because of the reduction in topsoil, which lowers yields and often results in crop failure. This outcome corroborates research of Elijah *et al*. (2018), where soil erosion was one of the main problems that faced yam farmers, particularly for states with fragile ecosystems like Delta State.

Table 2: Effects of climate change on yam farmers

Effects of climate change on yam farmers	Mean	Std. Dev	Remark
Water logging increased condition	3.51	0.632	High Effect
Soil salinity increase	3.42	0.611	High Effect
Reduced biodiversity	3.43	0.736	High Effect
Crop failure increase	3.44	0.834	High Effect
Yield decrease	3.61	0.652	High Effect
Insect infestation increase	2.41	0.789	Low Effect
Food shortage increase	2.42	0.815	Low Effect
Reduced soil fertility	2.43	0.855	Low Effect
Soil erosion increase	3.41	0.746	High Effect

Source: Field Survey, 2024. Where: HE = High Effects, AE = Average Effects, LE = Low Effects, NAAE = Not At All Effects

Constraints to climate change adaptation.

Table 3 result shows that low irrigation knowledge/Poor irrigation potential ($\bar{x}$= 2.43) was disagreed as constraint to climate change by the respondents.

High cost of seedlings: The farmers indeed agreed that the high cost of the seedlings ($\bar{x}$ = 3.12) is one of the major constraints to yam farming in Delta State and hence limiting their ability to adopt improved varieties that would have been more resilient to climate change. The finding affirmed the assertion of Olatinwo *et al.* (2023), that what causes farmers to face high input costs from improved seedlings; diminishes their capacity to augment productivity **Inadequate of climate change information:** The farmers need timely access to information regarding climate change ($\bar{x}$ = 3.21) for making proper decisions in the area of crop management and adaptation strategies. However, this was perceived as a very important constraint. This is in agreement with Ozioko *et al*. (2022), that farmers in Delta State generally lacked pertinent information on climate change and its impacts on agriculture. **Limited financial resources**: Limited financial resources ($\bar{x}$=2.92) constitute another formidable constraint to adapting to climate change. Most yam farmers cannot afford the cost of technologies, infrastructures, and practices that could help adapt the consequences of climate change. The finding is in tuned with Ibrahim (2024) who underlines constrained access to credit and financial capital as the main factor preventing farmers from utilizing innovative technological systems, improved seeds, and fertilizers which are all critical for enhancing climate impact resilience. **Shortage of Labour:** The shortage of labour was mentioned as yet another important constraint with ($\bar{x}$=3.03). Most of the adaptation practices, such as irrigation, mulching and soil conservation, require an additional labour input. A shortage of available labour hampers the farmers from effectively practicing adaptation to climate change. The finding corroborated Akinkuolie *et al*. (2024), that the scarcity of labour, partly induced by rural-urban migration and aging of farmers, constitutes one of the major binding constraints for farmers to adopt. **Low irrigation knowledge/Poor irrigation potential:** Irrigation is a very important strategy for reducing erratic rainfall effects that emanate from climate change. On the other hand, Low irrigation knowledge/irrigation potential-as asserted-is taken to be insignificant inhibitor to adaptation and by yam farmers, with a mean score of 2.44. The finding is in tandem with Ige *et al*. (2021) that irrigation systems remain highly underdeveloped across large parts of Nigeria, which implies that farmers still depend on rain-fed agriculture, though the latter has been turning out to be quite unreliable with changing rainfall patterns. **Shortage of land:** Another major constraint farmer has had to deal with in adapting to climate change concerns land. The respondents pointed out that land shortage ($\bar{x}$=3.32) restricts them from expanding the farm or adopting those adaptation practices that are intensive in the requirements of land. The finding affirmed Akinkuolie *et al*. (2024), that limited access to land prevents farmers from adopting more diversified cropping systems or conservation techniques that are basically required for improving the fertility of the soil and reducing vulnerability to extreme weather events. **Inadequate of technical and human resources:** Inadequate technical expertise and human resources ($\bar{x}$= 3.01) is the main factor that hinders the application of climate-smart agricultural practices. Most farmers have limited access to the technical knowledge that innovatively aids them in the adoption of improved seed varieties, precision farming techniques, and conservation agriculture. The finding is in line with Ozioko *et al*. (2022), that extension services are grossly under-resourced in most instances, while the extension agents themselves are undertrained in communicating adaptation strategies of climate change to farmers in Delta State. **High cost of improved varieties**: Just like the high cost of seedlings, the cost of accessing improved yam varieties was also an important constraint, as shown by the mean score of 3.31. Most improved varieties, usually resistant to drought, pests, and diseases, stand at the prime position to play a great role in adapting to climate change. The finding agreed with Amuwah *et al*. (2021) that emphasize improved varieties must be given at affordable and accessible measures to farmers for the augmentation of resilience to climate change. **Poor information delivery on early weather warnings from NIMET:** Poor early weather warnings delivered by NIMET was highly rated in the table with a mean of 3.42. For farmers, timely relevance of the meteorological early warning provides the ability to take effective protection from weather-related disasters like drought or flood. As Elijah *et al* (2020) pointed out, that the absence of timely and reliable weather forecasts remains one of the main reasons for farmers' uninformed decisions on planting and harvesting.

Table 3: Constraints to climate change adaptation.

Constraints	Mean	Std. Dev	Remark
High cost of seedlings	3.12	0.916	Agreed
Inadequate of climate change information	3.21	0.943	Agreed
Limited financial resources	2.92	0.980	Agreed
Shortage of labour	3.03	0.998	Agreed
Low irrigation knowledge/Poor irrigation potential	2.44	0.905	Disagreed
Shortage of land	3.32	0.760	Agreed
Inadequate of technical and human resources	3.01	0.749	Agreed
High cost of improved varieties	3.31	0.746	Agreed
Poor information delivery on early weather warnings from NIMET	3.42	0.854	Agreed

Source: Field Survey, 2024. Where: SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree

CONCLUSION

Adaptation measures employed by yam farmers in Delta State to counter the effects of climate change showed that reliance on weather forecast and information and irrigation practices were disagreed as usage of adaptation measures to climate change. Water logging, soil salinity, reduced biodiversity, crop failure and yield reduction were high effects of climate change. Inadequate political will and commitment, inadequate credit facilities and high cost of improved varieties were major constraints to climate change. Early warnings about weather from Nigeria Institute of Meteorology (NIMET) to farmers will help farmers plan well on yam production and have good output

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Conflict of Interest

The authors declared boldly that there are no conflict of interest

Authors Contribution

All the authors contributed adequately to the success of the work

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