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Original Research Article

Effects of Climate Change on Fluted Pumpkin (*Telfairia occidentalis*) Production in Itu District, Akwa Ibom State, Nigeria

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Abstract: This study assessed the effects of climate change on fluted pumpkin production and mitigation/adaptation measures used by farmers in Itu District, Itu LGA of Akwa Ibom State in Southern Nigeria. Random sampling and purposive sampling techniques were adopted for the selection of respondents comprising 100 fluted pumpkin farmers; 10 from each of the 10 communities that make up Itu District. FGD was used to elicit data on effects of climate change on fluted pumpkin production and climate change mitigation/adaptation measures. The study found the farmers perceived low yield of fluted pumpkin, loss of soil fertility, erosion, and declining family income as the major effects of climate change on fluted pumpkin production. Combination of fluted pumpkin production with other income generating activities was also found to be the most widely used mitigation/adaptation measure. The study recommended government effort through agricultural extension services and agricultural development programmes to mitigate/adapt climate change impacts by adopting improved varieties of fluted pumpkin seedlings, agricultural diversification, accurate and timely weather forecasting, use of cover crops, and disseminating up-to-date climate change information. Formation of co-operative societies among farmers to pool resources to fight the effects of climate change was also encouraged.

Keywords: Climate change, fluted pumpkin production, mitigation/adaptation measures.

1. INTRODUCTION

Agricultural production through small-scale farming is responsible for the majority of crops consumed in Nigeria. Many of them are central to the culture and survival of a community of people and any improvement in the production will certainly enhance the standard of living of the people (Ifeanyi-Obi *et al.,* 2012). One of such crops is fluted pumpkin. Fluted pumpkin (*Telfairia occidentalis*) is a tropical vine grown in West Africa as a leafy vegetable. Other names for the plant are fluted gourd and ugu (in Igbo language). Fluted pumpkin is a member of the Cucurbitaceae family indigenous to southern Nigeria (Akoroda, 1990). It is grown across the lowland humid tropics of West Africa with Nigeria, Ghana, and Sierra Leone being the major producers (Nkang *et al.,* 2003). It is grown mainly for its leaves which constitute an important component of the diet of many people in the region and its edible seed (Fagbemi *et al.,* 2005).

Fluted pumpkin is one of the important leafy vegetables in Nigeria grown and consumed in rural and urban areas. In the southern and southeastern regions of Nigeria, the young shoots and leaves of the plant are used primarily in soups and herbal medicines (Nwanna *et al.,* 2008). Although the fruit is inedible, the seeds produced by

the gourd are high in protein and fat and therefore, can contribute to a well-balanced diet. Thus, fluted pumpkin is ingrained in Nigerian agriculture and forms an important condiment in the national diet (Ibekwe and Adesope, 2010). It is a crop of nutritional and commercial importance to the people of Akwa Ibom State, Southern Nigeria. Nutritionally, it is grown mainly for the leaves and its edible seed because of their contribution to good health by providing inexpensive sources of minerals and vitamins needed to supplement people's diet which is mainly carbohydrates. Commercially, the production serves as a major source of income to the farmers and their households because they can give high yield per unit area of land and hence generate high income. Notwithstanding the numerous health and economic benefits of fluted pumpkin, several factors including climate change remains a serious obstacle to its production (Adeoye, 2020).

Fluted pumpkin is a dioecious, perennial and drought-tolerant plant that is usually grown trellised and requires a well-drained soil, adequate water and moderate sunshine to grow well. Though it tolerates drought to a reasonable extent, it is adversely affected by variations in climate (Ifeanyi-Obi *et al.,* 2012). As one of the most important and extensively cultivated food and income generating crops in many parts of Africa (Adebisi-Adelani *et al.,* 2011), numerous studies (Abu and Asember, 2011; Nwachukwu and Onyenweaku, 2009; Nwauwa and Omonona, 2010) among others have focused on the profit efficiency for small-scale farmers. However, few studies have considered the effects of climate change on its production. Hence, this study assessed the effects of climate change on fluted pumpkin production in Itu District and identified climate change mitigation/adaptation measures.

2. LITERATURE REVIEW

Climate Change and Global Warming

For over 100 years, the earth's average surface temperature has risen annually by about 0.74°C (Direct Gov., 2010). As global temperatures continue to rise, changes will likely be extreme and difficult to cope with (Ozor, 2009). Climate change and global warming are often used interchangeably to mean the same. Actually, climate change is the direct result of global warming i.e. global warming causes climate change. Climate change refers to a change or variability in the average temperatures of a region over a period of at least 30 years. IPCC (2007) defines climate change as a change in the state of the climate that can be identified (using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period typically decades or longer. Whereas, global warming is the increase in atmospheric temperature caused by the 'greenhouse effect' i.e. the atmosphere acts much like the glass panes of a greenhouse: it allows sunlight, particularly its visible range, to reach and warm the earth, but largely inhibits the infrared radiation emitted by the heated terrestrial surface from escaping into space. Greenhouse gases include water vapour which causes 36-70% of the greenhouse effect; carbon dioxide (CO_2) which causes 9-26%; methane (CH_4) 4-9% and ozone 3-7% (Kiehl and Kelvin, 1997). Some other naturally occurring gases contribute very small fractions of the greenhouse effect; one of these, nitrous oxide (N_2O) is increasing in concentration owing to human activity such as agriculture. Atmospheric concentrations of CO_2 and CH_4 have increased by 31% and 49% respectively above pre-industrial level since 1750 (Pearson and Palmer, 2000).

For nearly 100 years, climate scientists have gathered detailed observations of various elements of weather (temperature, precipitation, and storms) and of related influences on climate (ocean currents and atmospheric conditions). These data indicate earth's climate has changed over almost every conceivable timescale since the beginning of geologic time. Also, since the beginning of Industrial Revolution, human activities have had significant impact on climate change.

There are two basic sources of global warming: natural processes (biogeographical) and human activities (anthropogenic). Though a large number of the scientific and international community have attributed the rapid increase in greenhouse gases which include carbon dioxide (CO_2), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), methane (CH_4), nitrous oxides (N_2O), and water vapour to human activities, there is significant contribution from natural climate variability due to volcanic outgassing, combustion and natural decay of organic matter, and respiration by aerobic organisms. These sources are balanced, on average, by a set of physical, chemical, or biological processes, called 'sinks' which tend to remove greenhouse gases from the atmosphere. Significant natural sinks include terrestrial vegetation, which takes up CO_2 during the process of photosynthesis. In excess, these gases sit in the earth's atmosphere, absorbing the sun's radiation. Current levels are at volumes of 370 parts per million (ppm), up from 280 ppm over 100 years ago (Kigho, 2013).

The human activities that emit large amounts of greenhouse gases include industrialization, fossil fuel burning, gas flaring, urbanization, and agriculture. Conversely, human activities that reduce the amount of carbon sinks are deforestation, alterations in land use, water

pollution, and poor agricultural practices. These factors have being undeniably responsible for climate change (IPCC, 2007).

Climate Change in the Niger Delta Region of Nigeria

Agricultural production in the Niger Delta region of which Akwa Ibom State is part of is largely non-mechanized hence weather/climate assumes significance in every stage of production. Farmers depend on climate signals as a major determinant of their farming activities. Unfortunately, climatic conditions are not predictable as they used to be thus, farmers have encountered series of losses as a result of climatic changes (Apata *et al.,* 2009; Ozor, 2009). Agricultural activities through land use changes, deforestation, excessive use of chemical fertilizers, overgrazing, etc. are responsible for the accumulation of greenhouse gases in the atmosphere over the years resulting in climate change. The impact of climate change represents a major challenge to food security and contributes to high levels of poverty in Nigeria especially in the Niger Delta region as the region is more prone to climatic changes than other regions of the country due to oil exploration and exploitation that is resulting in environmental degradation of the area, and secondly, due to the economic and social importance of agriculture in the region (Ekpo and Nzegbule, 2012).

The Niger Delta is particularly vulnerable to climate change due to dependence on rain-fed agriculture, low levels of human and physical capital, poor infrastructure, pollution from oil activities, and low level of technology (IPCC, 2007). Climate-related hazards including severe storms, drought, flooding, sea level rise, salinity intrusion and river bank erosion have implications for food availability in Nigeria (NEST, 2004). Increasing sea levels means greater risk of storm surge, inundation and wave damage to coastlines, particularly in the Niger Delta region which is a low lying delta. Changes in rainfall will lead to drought or flood with far reaching implications for agriculture, forestry, fishing and health systems. Rising temperatures will result to shifts in crop growing seasons thereby affecting food security and will also cause changes in the distribution of vectors putting more people at risk from diseases such as malaria and dengue.

Climate Change and Fluted Pumpkin Production

Although fluted pumpkin is known to tolerate drought to a reasonable extent, it is adversely affected by climatic variations. All stages of fluted pumpkin production are affected by climate change (Ifeanyi-Obi *et al.,* 2012). Unfortunately, climate change is not completely avoidable because of the impossibility of entirely ending greenhouse gas emissions from both natural and anthropogenic sources. However, two responses to climate change are proposed: mitigation (i.e. reducing the release of or stopping further release of greenhouse gases into the atmosphere) and adaptation (surviving in the presence of climate change). According to IPCC (2007), mitigation is an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases, while adaptation is adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which allows the system to moderate harm or exploit beneficial opportunities. Building up mitigation and adaptation strategies which can help farmers cope with climate change is a basic way to manage the effects of climate change on fluted pumpkin production.

Given the commercial and nutritional importance of fluted pumpkin in the study area, it becomes imperative to assess the effects of climate change on fluted pumpkin production, and to identify viable mitigation/adaptation measures for farmers to reduce the effects. This will help them cope with climatic variations thereby increasing production. Precisely, the study assessed the fluted pumpkin farmers' perceived effects of climate change and their mitigation/adaptation measures.

3. MATERIALS AND METHODS

Study Area

The study was conducted in Itu District, Itu Local Government Area (LGA) of Akwa Ibom State located in Southern Nigeria. Itu LGA lies between latitude 5 ° 10'0'' N and longitude 7 ° 59'0'' E occupying a landmass of approximately 606.10 square kilometres with a total population of 127,033 (NPC, 2006). It is bordered in the North and North East by Odukpani in Cross River State and Arochukwu in Abia State, in the West by Ibiono Ibom and Ikono LGAs, in the South and Southeast by Uyo and Uruan LGA (Cross River and Akwa Ibom State Population Bulletin, 1983-1990). Itu LGA comprises of six districts namely: Itu District, Oku District, Mbiabo District, Ayadehe District, East Itam District, and West Itam District. Itu District comprises ten communities namely: Afia Isong, Akpa Ekpene Oton, Edem Inyang, Esin Ufot, Esuk Itu, Ikot Ukpo Itu, Obot Etim, Obot Itu, Odu Itu, and Okoho Itu. The mean annual temperature in Itu District is 29°C-34°C. Rainy season commences in March and extends to November, with July/August as the peak rainy months, while dry season occurs from December to February, reaching its peak in January when the harmattan wind sweeps across the entire area (Ayoade, 1998). Itu District has tropical rainforest vegetation characterized by relatively high humidity and rainfall making it suitable for fluted pumpkin production. It is also rich in flora and fauna, forests,

and fertile soils for cultivation which accounts for excellence in agricultural produce and returns.

Itu District has a mixture of rural and urban settlement; people are engaged in both formal and informal economic activities. Formal activities include public service, schools, hospitals, clinics, supermarkets, banks, etc. while informal activities include farming, fishing, hunting, handwork, small-scale trading, fish farming and livestock rearing. The area is prone to environmental disturbances resulting from anthropogenic activities such as deforestation for farmland, felling of trees for fuel wood, and pollution from oil exploration and exploitation activities.

Sampling Technique

Random sampling and purposive sampling techniques were adopted for the selection of respondents. Itu District was randomly selected out of the six districts that make up Itu LGA. From each of the ten (10) communities that make up Itu District, ten (10) farmers involved in fluted pumpkin production were purposively selected to form a sample size of one hundred (100) fluted pumpkin farmers. The main instrument for data collection was focus group discussion (FGD). The choice of FGD over questionnaire was due to anticipated low education level among the respondents (farmers). FGD sought information on the effects of climate change on fluted pumpkin production and climate change mitigation/adaptation measures. Descriptive statistical tools such as frequency count, percentage and mean were employed in data analysis, while tables were used for data presentation.

Below presentation and analysis of data from FGD focused only on the farmers' response to effects of climate change on fluted pumpkin production and climate change mitigation/adaptation measures.

Data Presentation and Analysis

Effects of climate change on fluted pumpkin production

The farmers' perceived effects of climate change on fluted pumpkin production conveyed their awareness of climate change and its effects.

Table 1 provides a summary of the farmers' perception of the listed effects of climate change on fluted pumpkin production.

Table 1: Effects of climate change on fluted pumpkin production

s/n	Effects of Climate Change	Mean Response
1.	Low yield of fluted pumpkin	4.7
2.	Loss of soil fertility	4.5
3.	Erosion	4.3
4.	Declining family Income	4.2

The effects were ranked on a 5-level Impact scale as follows:
1: Lowest, 2: Low, 3: Medium, 4: High, 5: Highest

Table 1 above shows the fluted pumpkin farmers' perception of the listed effects of climate change on their production. They indicated that the combined effects of climate change on fluted pumpkin production are: low yield of fluted pumpkin (4.7), loss of soil fertility (4.5), erosion (4.3), and declining family income (4.2). The high ranking of above 4.0 out of 5 on all four listed effects of climate change on fluted pumpkin production indicates an enormous significance of the negative effects of climate change on fluted pumpkin production.

Climate change mitigation/adaptation measures used by fluted pumpkin farmers

The climate change mitigation/adaptation measures used by fluted pumpkin farmers and their preference to each measure were ascertained.

Table 2 provides a summary of farmers' preference to the listed climate change mitigation/ adaptation measures.

Table 2: Climate change mitigation/adaptation measures used by fluted pumpkin farmers

s/n	Mitigation/Adaptation Measures	Mean Response
1.	Combination of farming with other income generating activities	4.80
2.	Use of organic manure	3.18
3.	Providing shade for the plants	3.08
4.	Mixed cropping	3.07
5.	Improving yield by use of fertilizer	2.90
6.	Irrigation practice	2.89
7.	Mulching to reduce water loss	2.87
8.	Delaying planting time	2.81
9.	Early harvest	2.77
10.	Increase land cultivated	2.71

The mitigation/adaptation measures were ranked on a 5-level Impact scale as follows:
1: Lowest, 2: Low, 3: Medium, 4: High, 5: Highest

Table 2 shows the farmers' preference to the listed climate change mitigation/adaptation measures. The rankings of the ten mitigation/adaptation measures used by fluted pumpkin farmers indicated that an overwhelming majority preferred adding other income generating activities alongside farming as the best way to mitigate/adapt to climate change problems. They ranked it 4.8 out of 5 compared to the next highest ranked measure (use of organic manure) at 3.18 out of 5. From the above response, it is clear that their opinion is from the perspective of income generation above other considerations.

4. RESULTS AND DISCUSSION

From the results of the analyses, it is very clear that the production of fluted pumpkin in Itu District, Itu Local Government Area of Akwa Ibom State is significantly affected by climate change. The farmers' opinion of climate change and its effects attests to this fact.

An analysis of the effects of climate on fluted pumpkin production showed that climate change is associated with low yield of fluted pumpkin, loss of soil fertility, erosion, and declining family income. These four effects received rankings of above 4.0 which indicate huge significance of their negative effects on fluted pumpkin production.

An analysis of the climate change mitigation/adaptation measures employed by the farmers indicated that a combination of farming with other income generating activities was the most preferred option with a ranking of 4.8 out of 5. This implies that their major aim of fluted pumpkin production is income generation, therefore when income generation from the production gets low they are left with no better option than to combine it with other income generating activities like trading, handwork, fishing, hunting, and livestock rearing.

5. RECOMMENDATIONS

The result of this study established that climate change pose a significant threat to fluted pumpkin production in Itu District, Itu Local Government Area of Akwa Ibom State. The effects of change climate as discussed in this study are already militating against fluted pumpkin production in the area. Based on these findings, government effort is recommended through agricultural extension services and agricultural development programmes to assist the farmers in implementing the following climate change mitigation/adaptation measures:

i. Adopting improved varieties

Developing and using new varieties of fluted pumpkin seedlings with increased resilience to flooding and declining soil fertility is important for climate change adaptation. Also, improvement by the adoption and dissemination of short-duration varieties of fluted pumpkin can enhance farmers' ability to cope with climatic variability in the area (Agwu, 2008).

ii. Diversification of livelihoods

In rural Nigeria as a whole and in communities around Itu District in particular, vulnerability to climate change is worsened by the high level of poverty concomitant with limited options for coping with falling income. This can be reduced by diversifying livelihoods. The fluted pumpkin farmers can combine farming with livestock rearing such as chickens, rabbits, pigs and goats in an integrated manner to enhance their income. They can engage in these income generating activities particularly during raining season when most of their farmlands are flooded.

iii. Accurate and timely weather forecasting

A major factor of crop failure is poor weather information dissemination in the area. Farmers usually rush to plant their crops with the first rains which may not necessarily signal the actual onset of the growing season. Better weather forecasting skills and information sharing is needed to assist farmers in this respect. Responsible agencies such as Nigerian Meteorological Agency (NIMET) and other relevant research institutes should be strengthened to assist the farmers in the area with timely information.

iv Use of cover crops

The use of cover crops that are nitrogen-fixing ensures the nutrient enrichment of the soil for succeeding cropping seasons. Soil loss due to sheet erosion is an important factor affecting fluted pumpkin production. Fluted pumpkin which is a creeping plant can be grown alongside other creeping crops like potatoes, cowpeas, melon, water melon, and groundnut as cover crops. This measure can be integrated into the farming system of Itu communities to reduce loss of top soil due to erosion and sustain crop production.

v. Climate change information dissemination

It is also important that the agricultural agencies of government should regularly disseminate up-to-date useful and relevant information about climate change including mitigation/adaptation measures to farmers, in addition to paying regular visits to their farmlands to monitor and record improvements in their continuous action against climate change.

Lastly, the formation of co-operative societies by farmers will help to pool resources to fight the effects of climate change more vigorously.

6. CONCLUSION

This study on the effects of climate change on fluted pumpkin production in Itu District, Itu Local Government Area of Akwa Ibom State revealed that climate change is a real danger to the farmers and their production. It also identified the mitigation/adaptation measures of the farmers against the effects of climate change. The study made it clear that the farmers should know and do more than they are currently doing. They need further training on climate change mitigation/adaptation measures, improved technology in production, formation of co-operative societies, and other income generating activities. Most of these improvements cannot be made without the backing of government. Therefore, government effort is needed through agricultural extension services and agricultural development programmes for assistance in the better management of climate change impacts.

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