



# Growers Adaptation Strategic Alleviation of Climate Variability in Peri-Urban Agriculture for Food Security in Calabar – Nigeria

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## Authors' contributions

*This work was carried out in collaboration between all authors. Author MAY designed the study, provided the background, wrote the first draft of the manuscript and review relevant empirical work.*

*Author FEB provided the methodology, wrote the protocol and review the first draft. Author AEO performed the statistical analysis, carried out mapping and description of the study area and wrote the abstract. All authors read and approved the final manuscript.*

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## ABSTRACT

This study examined the adaptive mechanisms employed by farmers in stabilizing crop yield against the wave of climate variability in Calabar, Nigeria. The study adopts a participatory approach based on focused group discussion and questionnaire survey to examine the farmers' perception of climate variability, adaptation strategies and the influence of the strategies on crop yield. A total of 180 farmers were randomly selected for the study. The results revealed that in response to climate variability 16 strategies were adopted by farmers to stabilize crop yield in line with their indigenous knowledge systems. On indexing and ranking of the strategies based on their priorities, six strategies were predominant which include multiple cropping, use of improved crop varieties, soil conservation, planting cultivars that suit climate, intercropping, changing planting pattern. Multiple

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cropping with adaptation index of 638 and 94.5 response on climate and land criteria as well as use of improved varieties with adaptation index of 500 and 100% response on mixed criteria of climate and land were outstanding. Crop combination including vegetables, cereals, spices and roots were preferred. Though cassava is highly cultivated, pumpkin has the highest preference due to its market value and demand. The driving factors behind farmers' choices of adaptation were informed by yields and availability of land. Farmers considered yields and income as the factor in selecting resilience crops. Undoubtedly, 80% of farmers that have adopted these practices no longer experience the persistence of the various environmental problems arising climatic variability. The implication is that indigenous knowledge system on the use of improved varieties and suitable cultivars as well as soil management is essential for improved and bountiful harvest to feed the teeming population amidst climate change. The paper reveals that adaptive measures taken by crop farmers to cushion the effect of climate on crop yield are effective. Hence, it is recommended that indigenous knowledge should be considered alongside other scientific knowledge to combat the impact of climate variability on agriculture while improving crop yield.

*Keywords: Farmers; adaptation strategies; climate variability; sustainable agriculture; food security; Indigenous knowledge systems; planting pattern.*

## 1. INTRODUCTION

One of the significant environmental issues of extreme concern in the world today is climate change. Climate change is the most critical of all environmental challenges because of its social and economic threats to life support systems. It is predicted that climate variability and change in sub-Saharan Africa will have devastating impacts on agriculture and land use, ecosystem and biodiversity, human settlements, diseases and health and water resources [1]. This is because over a decade now, climate change has affected crop sub-sector of agriculture that is critical for livelihoods in Africa; where much of the population, especially the poor, rely on local supply systems that are sensitive to climate variation [2,3]. In addition, there are other resultant environmental problems arising from climate change which also affect agriculture which include, aggravated soil erosion, flood disasters, desertification due to the effect of shifting agriculture in fragile soils, forest etc. [4,5].

African farmers are the most vulnerable to changing climatic variations due to low capacity to adapt to such changes. Also, increase in environmental hostile practices such as clearing in erosion prone and flood prone areas, bush burning, shifting cultivation, tillage, etc. that continue unabated exacerbate the adaptive capacity of farmers in Africa. Thus, better understanding of adaptation to the prescribed situation for increased productivity in the agricultural sector is a *sine qua non*.

Adaptation or adaptive capacity of farmers as described by IPCC, [6,7] connotes the ability of

farmers to adjust to the change (climate change including variability and extremes) to moderate or reduce potential damage, take advantage of opportunities or to cope with the consequences of the event. The adjustments is to enhance the viability of social and economic activities and to reduce their vulnerability to climate variability [8-10]; Adaptation measures are important to help farmers to better face extreme weather conditions and associated climatic variations [11,12].

Although agriculture is largely a rural-based activity, urban agriculture is an important complement to rural food supply and a buffer against food insecurity in many of the world cities. Peri-urban cultivation contributes to urban fruit and vegetable supply. In [13], studies showed that urban agriculture contributes to a large extent to the food security of many major cities, both as an important component of the urban food system and as a means for vulnerable groups to minimize their food-insecurity problems. City case studies indicate a considerable degree of self-sufficiency in fresh vegetable. In Europe, [14] used a productivity level of 10.71/ha, and showed that London is estimated to produce around 232,000 tons of fruits and vegetables or 18 percent of the population's nutritional needs. In a study carried out by [15], urban commercial gardens in the United States utilized raised beds, soil, amendments, and "season extenders" such as row covers and hoop houses to produce yields which can be 13 times more per acre than rural farms.

In Sub-Saharan Africa, [13] recorded 40 percent of urban farmers in Africa involving in urban

agriculture. In [16], it is observed that Dakar produces 60 percent of its vegetable consumption while in Accra 90 percent of the city's fresh vegetable consumption is from production within the city [17]. In Zaria (Nigeria), also, aerial photography showed that 66.2 percent of the urban area was cultivated [18]. This is the same in the ancient city such as Calabar in Nigeria, that even when urban infrastructural development have determined that agricultural activities be located on the periphery, pockets of crop cultivation still exist here and there.

Though, climate change has been known to affect agriculture and if the trend persist will concomitantly has a prolonged effect on food security [19-23]. Growers have adopted farm management practices that can be used the changing planting and harvesting season. Climate is an important resource to crop production in Nigeria especially in the rainforest Zone of Nigeria as farmers depend largely on rainfed agriculture [24,1]. The key point therefore is how farmers in the zone respond to climate change through their farming activities. For Nigeria specifically, [25] has established the relationship between climate variability and crop productivity in the semi-arid region. The arid northeast region of Nigeria is facing the increasing trend of drought which has exacerbated the fast reduction in the amount of surface water, flora and fauna resources on land [26]. Constant decline in rainfall usually result in reduction in the natural restoration rate of degraded land resources [27,28]. The effect of these changes is posing serious threat to food security in Nigeria. Since agriculture in Nigeria is mostly rain-fed, it therefore implies that any change in climate is bound to negatively affect its productivity in particular and other socio-economic activities in the country. The impact could, be measured using indicators such as crop growth, availability of soil water, soil erosion, incident of pest and diseases, sea level rises and decrease in soil fertility among others [29].

In Nigeria and Calabar in particular, despite the challenges of climate variability, farmers have adopted some livelihood coping strategies to adapt/mitigate the incidences of climate variability/change in their areas. Though Calabar as well as other southern part of Nigeria is not under extreme threat of drought as the north, however, the irregular pattern of rain and fluctuations especially rain-on-set to usher in

planting season is now unpredictable and hence farmers can no longer predict when to start cultivation of certain crops in anticipation of rain. Prolong dry season is also a problem, unlike the north with dams for irrigation. Calabar is without dam or irrigation facilities thereby aggravating farmers' dilemma. Climate variables such as temperature, humidity, rainfall, wind speed and other climate are likely to have pronounced effect on crop production in south just as in the northern part of Nigeria. However, there is a wealth of local knowledge based on predicting weather and climate [1].

As noted by [30], adaptation occurs at two main scales: (a) the farm-level that focuses on micro-analysis of farmer decision making and (b) the national level concerned with agricultural production at the national scales in tandem with domestic and international policy. This study, particularly envisage adaptation at micro level. The supposedly problems prevalent in the agricultural production basically the crop sector, in Calabar is the variability in climate especially in terms of the rainfall pattern, strong wind and certain human activities. These often lead to environmental problems such as erosion and flood if not properly managed. This therefore indicates that adaptation is one of the policy options for reducing the negative impact of climate variability on crops [12,31,32].

The findings from the several studies elsewhere indicated that, variability in climate could result to either change in the cropping pattern, types of crops cultivated and seasonality in cropping among others. For instance attempts have been made to study farm level adaptation methods in the rainforest zones of Africa [30,33-36]. Of these studies, none of them have attempted to study the adaptation to climate change in the study area in particular. Such study has not been carried out in Calabar neither has it been given adequate empirical policy attention and academic scrutiny. The novelty of this study in Calabar is, however, intended to fill this gap.

This study seeks amongst others to examine the farmer's perception, response and adaptation strategy to climate situation in the study area, and will further suggest policy direction to ameliorate these impacts.

## 2. STUDY AREA

The study was conducted in peri-urban areas of Calabar which is the capital city of cross River State in the south-south geopolitical zone of

Nigeria, located between latitudes 8° 20'E and 8° 40'E and longitudes 4° 50'N and 5° 30'N (Fig. 1). Calabar is divided into Calabar Municipality and Calabar South Local Government Areas respectively. Essentially, Calabar is an inter-fluvial settlement, built on a high land between two adjacent river valleys, it is sand witted by the Great Kwa River on the east that flows into an estuary (the Cross River Estuary) and the Calabar River on the west. It stretches northwards to Ikot Omin bordered by Odukpani Local Government Area, East by Akpabuyo Local Government Area and South by the swamps of the mangrove forest. Major growth and expansion takes place northwards due to the existence of these two river systems.

Calabar is marked by heavy rainfall than most parts of the country but with seasonal variations and generally lower daily temperatures. It has over 3,500 mm of rain with a double mixima (April-July and September- October), (Nigeria Airport Authority Weather Report 1995). The area is also susceptible to sheet and gully erosion. Calabar is nevertheless a dynamic centre, which constitutes a high concentration of migrants from rural areas and other states of the country. It has a rich cultural heritage coupled with its aesthetic beauty, which has in recent times attracted tourists from all over the world. Thus, the area is fast becoming a cosmopolitan city as evident in the influx of people of different nationalities and race worldwide.

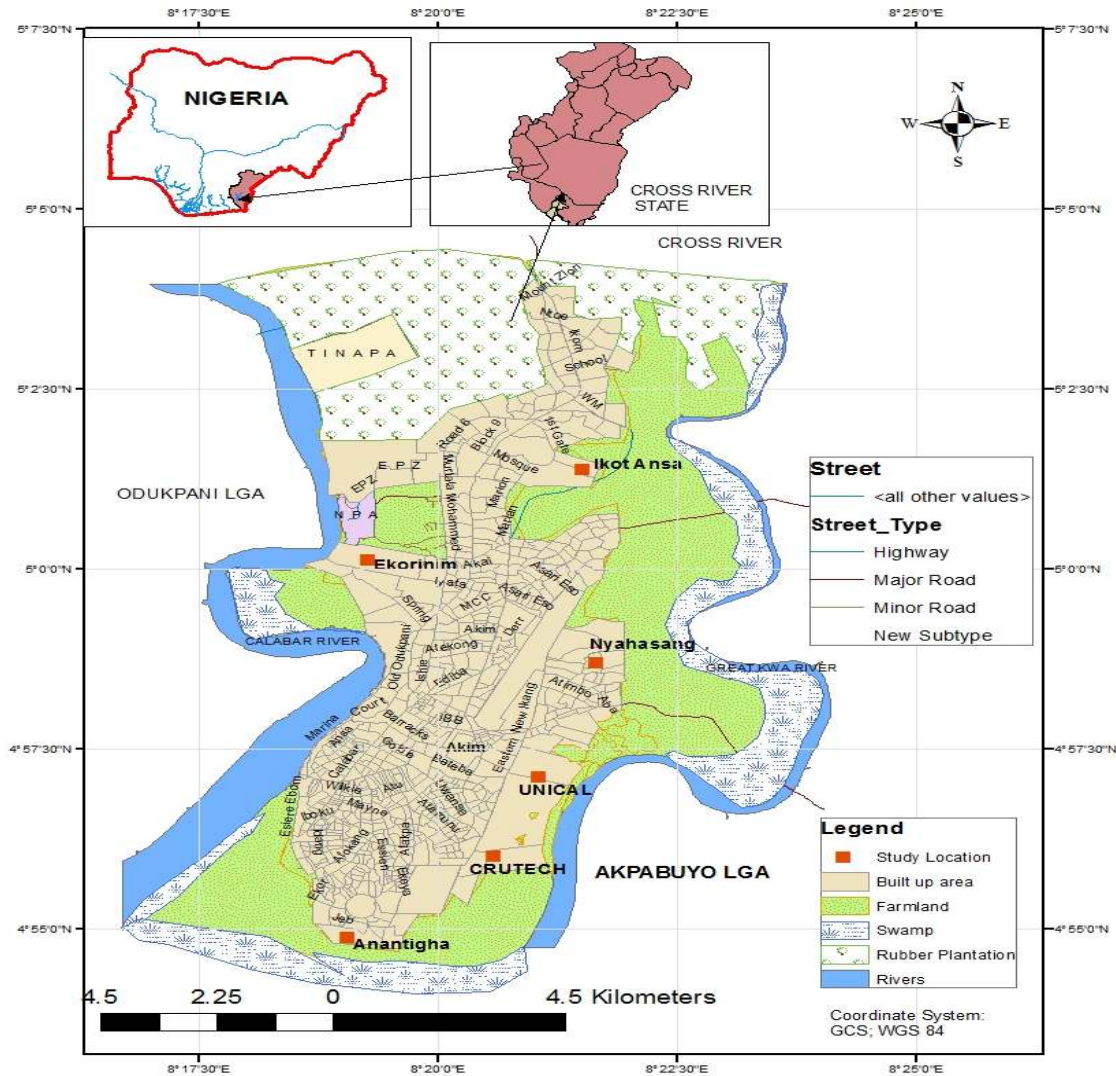


Fig. 1. The study locations

Most of the land, which forms the basis of the present distribution of land use in Calabar, was acquired in small parcels for uncoordinated purpose, which hardly ever projected beyond a limited number of years [37]. The available data from the study carried out by [38], indicates that agricultural land use occupied 4.83 km<sup>2</sup>; built up area occupied 95.05 km<sup>2</sup>; shrub land 29.17 km<sup>2</sup>, while a greater portion of 331.01 km<sup>2</sup> was occupied by other land uses such as mangrove and fresh swamp.

### 3. METHODS

Essentially, the study area was made up of six (6) locations drawn within Calabar. These areas are among the core areas of urban agricultural activities. The areas were as follows; Ikot Ansa, Ekorinim, Nyaghasang, University of Calabar (UNICAL), Cross River University of Technology (CRUTECH) and Anantigha. The areas were randomly sampled from the list of locations within Calabar where farming activities are carried out. To have a fair representation of the area chosen and to give the respondents equal chance of being selected for the study, a stratified random sampling technique was employed to select the locations of study and a total of 180 respondents from the six (6) locations in the study area without gender bias. The southern, central and northern axis of the city form the strata for the groupings of farming locations in urban area. Since the farming locations were few, this informed the selection of 50% of the locations based on proportion in each stratum which made up the six study locations. The number of farms in the selected areas were visited for the enumeration and listing of farmers in the area by gender. Thus, a simple random sampling was then used in the selection of 50% of the respondents (farmers) for the administration of questionnaire.

Structured questionnaire and Semi Structured Interview (SSI) through Participatory Research Appraisal (PRA) methods were used to obtain information from the field. Multiple choice question items were used in the questionnaire to elicit information from the respondents. Information elicited using questionnaire include types of crops cultivated in the different sampled location in Calabar and also choice of farming activities and problems encountered. Participatory method through Focused Group Discussion (FGD) was used to interact with the people to assess the various mitigation strategies and the reason for such strategies. Moreover,

information on the preferences and selection of crops was also elicited from the farmers. The PRA was also used to complement information from questionnaire; ranking was carried out to evaluate the preferences of farmers.

The data were collated by location to see the spread. Frequency which denotes the number of respondents that attest to a particular item was used in the analysis, while simple percentage was calculated in respect to the total respondents as given below.

$$\frac{\text{No. of Response}}{\text{Total Respondents (180)}} \times 100$$

Aggregate is the total sum of the frequencies in the different categories. Moreover, adaptation index was calculated from a four point likert scale from the questionnaire. The frequencies under each scale were summed up to give a total value for each item. Weight estimation was carried from the scale using their assigned utility values with a cancel-out effect on the variables under consideration to reveal the real cumulative weight of a given adaptive strategy. Here, the weights were given by 4, (strongly agreed), 2 (Agree), -2 (Disagreed), and -4 (Strongly disagreed) respectively. Ranking was based on the highest values obtained using the calculated percentages and index. Different criteria were used to assess the preference. The minimum and maximum represents the range of the distribution (the highest and the lowest).

### 4. RESULTS

#### 4.1 Characteristics of Urban Agriculture in Calabar

Calabar, urban agriculture is mostly found at the vacant inner- city plots, home garden, school gardens, community gardens, green belt around the city and urban fringes. The farms here are suitable for the production of mostly vegetables, tubers and roots, trees, cereals and legume crops. The cropping types in the area of study are presented in Table 1a. The data show that 22% of the farmers practiced mono cropping while 78% were mixed croppers i.e. more than double areas are under multiple cropping. Mixed cropping is seen as a strategy for coping with climatic variability where some crops can withstand stress should unfavorable conditions arise. The various proportions of the crop type were equally shown in Table 1b (aggregates for the crop types). The Local food grown in the study area includes vegetables of all sorts,

cereals, spices, tuber and roots and tree crops. The table indicates that cassava is largely cultivated indicated by aggregate response of 48%, this is followed by maize which is also the largely cultivated crop type in monocrop system (42%). Pumpkin followed by water leaf and vegetables in the category of vegetables are third and fourth widely cultivated crops. On the basis of preference, the crop types were ranked to show the highly preferred crops. Vegetables are the most preferred crops for cultivation. Pumpkin ranks first, followed by waterleaf, okro, maize, cassava, and yam, and so on (Table 2). Pumpkin therefore is the most preferred crops. Vegetables are preferred due to farmers' ability to cultivate them on a small area that can be taken care off. Vegetables also have high market value and take a shorter time to cultivate.

#### 4.2 Farmers' Preference of Adaptation Strategies and Effectiveness to Climate and environmental Change Situation in the Study Area

The adaptation strategies and preference by growers were assessed based on their experience. These strategies are based on what growers think can best solve farming problems. From appraisal of growers responses on adaptive measures to climate variations and environmental changes affecting the farming process, indices for counter measures to combat the observed changes in the yield of crops were derived. The ranking of these indices is presented in Table 3. It can be seen that the most prevalent adaptation method used in the study area is multi-cropping with an adaptation index of 638; where farmers plant different crop varieties that survive in adverse climatic conditions. 94% of the respondents attribute its usage to climate conditions (Table 4). This is closely followed by the use of improved crop varieties with an index of 500 (Table 3) and 100% response on climate and land criteria (Table 4). In this case, all

respondents attribute its use to the joint contribution of climate and human variables (Table 4). Other prevalent adaptation methods in the study area include soil conditioning by applying fertilizer; index of 458, cultivation of crops that suit the observed climate conditions; index of 434, inter cropping; index of 358, change in planting pattern; index of 298, and soil conservation by applying fertilizer and organic manure with a utility index of 192 (Table 3). The driving factor behind their choices in majority of the methods adopted to keep yield stable and on the path of increase is due to a combination of climate variability and land availability (Table 4). Most of these strategies are essential for plants growth especially fertilizer and manuring, however, farmers opinion are that in normal conditions these element may not be necessary in the area.

Common problems encountered by farmers during farming in the study area include erosion, flood, drought, pest and pilfering, some of which could be as a result of weather conditions or human factors. The effectiveness of the adaptation strategy was assessed on the persistency of the problems after the application of the adaptation strategy. About 80% of the farmers appear not to experience severe cases of farming problems after the adoption of the strategy, and perceive the inherent problems no grave consequence to them through the adoption of the strategies, while 20% of farmers interviewed appear to suggest otherwise. A descriptive statistics of the respondents' perception of the effectiveness of the strategy adopted in solving common problems encountered in farming in the study area is represented in Table 5. Adaptive measures are then taken by crop farmers to cushion the effect of these problems on crop yield with the assumption that measures adopted may have been informed by changes in climate variability and /or human environmental conditions.

**Table 1a. Proportion of farmers practicing different cropping systems in the study area**

Locations	Mono cropping		Mixed cropping		Total	
	Frequency	%	Frequency	%	Frequency	%
Anantigha	11	33	23	68	34	100
Crutech	7	23	23	77	30	100
Ekorinim	6	30	14	70	20	100
IkotAnsa	1	3	39	98	40	100
Nyaghasang	6	25	18	75	24	100
Unical	8	25	24	75	32	100
Aggregate	39	22	141	78	180	100

Source: researchers' field survey data, (2013). (% (corrected)

**Table 1b. Types of crops cultivated within the study area**

Types of crops	Scientific name	Anantigha		Crutech		Ekorinim		Ikot Ansa		Nyaghasang		Unical		Aggregate	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1) Water leaf	TalinumTriangulare	10	13	19(1)	20(17)	8(2)	17(33)	23	15	9	12	17(1)	17(14)	86(4)	16(10)
2) Pumpkin	TelferiaOccidentalis	11	15	20(1)	22(17)	8	17	26	17	10	14	13(1)	13(14)	88(2)	16(5)
3) Okro	Abetmosausxilentus	11	15	8	9	6	13	19	12	12	16	13	13	69	13
4) Melon	Cucimismelo	1	1	-	-	-	-	3	2	-	-	2	2	6	1
5) Cucumber	-	-	-	1	1	-	-	-	-	-	-	-	-	1	0
6) Green	AmarantusCordatus	3	4	3	3	-	-	-	-	1	1	3	3	10	2
7) Garden egg	Solanimetongena	-	-	-	-	-	-	1	1	-	-	-	-	1	1
8) Bitter leaf	Veroniaamygdalina	7	9	6	6	-	-	4	3	3	4	1	1	21	4
9) Maize	Zea mays	4(5)	5(42)	15(2)	16(33)	6(3)	13	8	5	12	16	16(2)	16(29)	61(12)	11(31)
10) Scent leaf	Ocimumgratissimum	-	-	-	-	-	-	3	2	-	-	-	-	3	1
11) Curry leaf	Helichrysumitalicum	-	-	-	-	-	-	1	1	-	-	-	-	1	0
12) Pepper	Capsicum frutecens	2	3	4	4	2	4	4	3	1	1	7	7	20	4
13) Yam	Dioscorea SPP	8	11	4	4	5	11	5	3	4	5	7	7	33	6
14) Cocoyam	Xamthosomasagittifolium	2	3	1	1	3	6	9	6	4	5	5	5	24	4
15) Cassava	ManihotSpp	10(6)	13(50)	9(2)	10(33)	6(1)	13(17)	23(1)	15(50)	9(2)	12(33)	9(2)	9(29)	66(14)	12(36)
16) Sweet yam	Dioscorearotundata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17) Water yam	Dioscoreaalata	-	-	1	1	-	-	-	-	-	-	5	5	6	1
18) Mango	Maniferaindica	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19) Oranges	Citrus sinensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20) Black pears	Dacrodesevilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21) Banana	Musa Sapentum	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22) Plantain	Musa paradisiacal	5(1)	7(8)	2	2	3	6	4	3	8(2)	11(33)	2(1)	2(14)	24(4)	4(10)
23) Avocado pear	Persagratisima	-	-	-	-	-	-	17	11	-	-	-	-	17	3
24) Sugar cane	-	1	1	-	-	-	-	4(1)	3(50)	-2	3(33)	-	-	5(3)	1(68)

Note: Values in parenthesis are proportion of mixed croppers against the mono croppers, Freq. = Frequency and % = Percentage  
 Source: Researcher's field survey data, (2013); (Remove fractions after decimal by rounding out %)

**Table 2. Preference ranking of crop types**

Local food grown	Order of preference												Rank
	1st	2nd	3rd	4th	5t h	6th	7 <sup>m</sup>	8th	9th	10th	Min.	Max.	
<b>Vegetables</b>													
1. Water leaf	171	21	14	91	14	93	101	140	124	126	14	171	2nd
2. Pumpkin	176	114	124	149	10	41	94	6	10	6	6	176	1st
3. Okro	141	102	119	70	14	42	65	11	14	2	2	141	3rd
4. Melon	18	11	19	6	2	9	8	19	18	12	2	19	11th
5. Cucumber	2	-	1	1	-	-	-	-	-	-	1	2	16th
6. Green	10	8	12	16	6	4	2	1	8	4	1	16	13th
7. Garden egg	2	1	6	14	3	8	4	3	1	-	1	14	14th
8. Bitter leaf	94	81	14	90	1	20	41	61	22	44	1	94	9th
9. Maize	127	98	16		18	62	41	8	9	1	1	127	4th
<b>Spices</b>													
10. Scent leaf	18	11	9	10	7	3	6	2	1	-	1	18	12th
11. Curry leaf	2	-	-	-	1	-	-	-	-	-	1	2	16th
12. Pepper	90	62	81	95	3	12	18	11	26	9	3	95	8th
<b>Tubers and roots</b>													
13. Yam	96	40	28	14	9	13	65	94	44	46	9	101	6th
14. Cocoyam	62	90	11	95	3	12	9	82	26	18	4	97	7th
15. Cassava	102	112	9	51	12	12	76	119	103	100	9	119	5th
16. Sweet yam	-	2	1	-	1	-	-	1	1	-	1	2	16th
17. Water yam	93	69	60	76	61	16	28	43	6	18	6	93	10th
<b>Trees</b>													
18. Mango	-	-	-	-	-	-	-	-	-	-	-	-	-
19. Oranges	-	-	-	-	-	-	-	-	-	-	-	-	-
20. Black pears	-	-	-	-	-	-	-	-	-	-	-	-	-
21. Bannana	-	-	-	-	-	-	-	-	-	-	1	12	15th
22. Plantain	-	-	-	-	-	-	-	-	-	-	-	-	-
23. Avocadopear	-	-	-	-	-	-	-	-	-	-	-	-	-
24. Sugar Cane	-	-	-	-	-	-	-	-	-	-	-	-	-

**\*\*Min. is the lowest value in the range, while max. Signifies the highest value calculated from the frequencies at different order\*\***  
 Source: Researcher's field survey data, (2013)

## 5. DISCUSSION

In the bid to enhance sustained yield, growers adopts practices best suited for their environment. Mixed cropping was the dominant peri-urban agricultural system within the study area. A large proportion of farmers (78%) preferred crop mix to mono crop. The major reason is to diversify crops and increase output. As noted by [39], one way of achieving sustainability in the face of environmental changes is mixed cropping in sequence. The mixed cropping system diversify crops production and improve resilience of crops for increase yield in the face of climate variability. Moreover, the mixed cropping system adopted by growers usually involve crop combination such as vegetables, cereals, spices and root crops etc. the largely cultivated crop is cassava with aggregate of 48% response. However, despite the dominance of cassava over other crops, the most preferred crop is vegetable particularly pumpkin, water leaf, Okro and maize. The high preference for vegetable is due to increased market value and high demand for vegetables. Vegetable does not necessarily require a large

area of land like cassava. Apart from cultivation of resilience crops, most of the crop mix is driven by economic benefits. The selection of the crops therefore considered resilience and the market demand which implies high income producing crops. [21] also added that sustainable agriculture simultaneously increases production and income, adapts to climate change and reduces GHG emissions and providing other benefits.

From Table 3, the adaptation strategies adopted in the study area has been presented from calculation of indices to find its prevalence, one discovers that six adaptive measure standout as the most practiced measures to counter poor yield. Notable among them in order of preferences were: multi cropping to survive adverse climatic conditions, the use of improved crop varieties, fertilizer usage, the use of cultivars that suit climatic conditions, intercropping and the change in planting pattern. PRA with the farmers discovered the following: Multi-cropping has the highest adaptation index. It shows that it widely used measures, however, Table 4 showed that about 94% of the crop



farmers preferred this strategy based on the criteria of combating climate variability and availability of land, while the use of improved varieties was the second outstanding strategy but gained 100% response on preference in combating climate [1], corroborate this study by adding that most rural communities possess traditional and local knowledge that may help them adapt better to the impacts of climate variability/change. For example, growers from their experience will know the best crop for a particular season and other conditions.

Climate variability/change with expected long-term changes in rainfall patterns and shifting temperature zones are expected to have significant negative effects on agriculture and food security [40]. Thus, cultivating of such crops, which survive adverse climatic conditions tend to reduce the risk of poor yield irrespective of the weather conditions within this period. These crops tend to coexist easily. The resulting genetic diversity heightens particular strains of crops, meet the farmers' nutritional needs and enable them gain other use benefits [41].

Multi-cropping systems as widely accepted and adopted as a strategy to combat climatic variability is also supported by [42] that it ensure sustainability of subsistence farmers and improve

their output. Low risk is certain in the case of stress as some crops will withstand stress as opposed to mono-cropping where a particular disease can affect the entire farm. This is supported by the work of [39] that diversification of Crops has numerous economic benefits ranging from buffer against risks of stress to productivity.

Application of fertilizer by farmers is third highly ranked measure in adapting to climate change effect on crops in Calabar. Farmers reported that fertilizer was a kingpin in enhancing crop production. It is a key to securing their food need at maximum level especially on small farm holdings. Application of Fertilizer can produce a healthier crop that is able to withstand the effects of crop diseases and pests. It aids in replenishing and maintaining long-term soil fertility by providing optimal conditions for soil biological activity, suppresses pathogenic soil organisms, aid in rebuilding depleted soil and even aid in reducing soil erosion among others.

Introducing crops that do well in the climatic situation of Calabar was also considered as the fourth adaptation methods of high prevalence in Calabar to cushion the effect of climate variability on crop yield. The field survey in the study area showed 96% of farmers will employ these kinds

**Table 3. Adaptation strategy index and ranking**

S/n.	Adaptation strategy	Index	Rank
1	Multicropping (Plant different crop varieties that survive in adverse climatic conditions)	638	1 <sup>st</sup>
2	Use improved crop varieties	500	2 <sup>nd</sup>
3	Do soil conditioning such as applying fertilizer	458	3 <sup>rd</sup>
4	Crops adaptable to the pattern of climate/crops that do well in this kind of climatic situation i.e. (plant cultivars that suit climate).	434	4 <sup>th</sup>
5	Do inter cropping	358	5 <sup>th</sup>
6	Change planting Pattern	298	6 <sup>th</sup>
7	Do soil conservation such as applying fertilizer and organic manure	192	7 <sup>th</sup>
8	Changing tillage operations: the options in this category are using minimum tillage operations, full tillage operation and digging ridges across slopes in the farm against erosion.	146	8 <sup>th</sup>
9	Change time of planting: this covers early planting and late planting options	138	9 <sup>th</sup>
10	Do soil conservation such as planting of cover crops.	48	10 <sup>th</sup>
11	Do soil conservation such as applying organic manure	8	11 <sup>th</sup>
12	Do soil conservation such as mulching	-12	12 <sup>th</sup>
13	Plant insect resistant crops	-62	13 <sup>th</sup>
14	Use modern technologies as advised by extension agents	-160	14 <sup>th</sup>
15	Resolve to tree planting in the farm to serve as shade against harsh temperature	-360	15 <sup>th</sup>
16	Appease the gods of our land	-690	16 <sup>th</sup>
17	No adaptation	-	-

*\*\*Index calculated from likert scale based on assigned utility values and, Ranking from highest percentage\*\* Source: Researcher's field survey data, (2013)*

of cultivars (Table 4) based on a singular criterion of climate variability. Adapting crops to local ecological situations will reduce risk due to climate change and will allow cultivation to continue on current areas as well as taking advantage of new suitable areas. These crops include mostly, pumpkin, maize and waterleaf.

Intercropping of crops (planting more than one crop on the farm) was also preferred by 80% of farmers. Intercropping appears to have many advantages. Here, farmers reported that intercropping stabilize yield over the long-term, promote diet diversity and maximize returns under low levels of technology and limited resources. The results of this analysis agree with the findings of other researchers for example [43-47]. They opined that crop mixture guarantees the preservation of crop diversity and also copes with the vagaries of challenging environment. Climate variability can also be combated through system such as shifting cultivation, mulching etc. Also, intercropping of many types of crops guarantees ecological stability as it suppresses weeds and insects effectively, assists in erosion control and allow for biological management of soil fertility which can undermine food security [48,49].

Furthermore, the socio-economic and ecological advantages of intercropping include better and more reliable yields due to the diversity of crops in question, which is a food security attribute where farmers do tend to minimize risk in preference for maximizing profit. This method also maximizes space, water and available nutrients. It reduces the ability of disease to spread and do extend throughout the period of the year during which the soil is protected by leaf cover and the root systems. Farmers in their traditional intercropping systems, the diverse crop species are usually grown together to complement one another by using resources in different ways. Sequential harvesting and risk of total crops loss is averted. Farmers primarily increase diversity of products and stability of output at their farms through adoption of intercropping which is of the products of indigenous knowledge system [50]. However, with rapid increase in population and less chance of bringing new lands under cultivation, intercropping seems to be a way to increase products and stabilize annual output at their farms.

As was presented in Table 5, we find that only 20% of the respondents claim to experience

**Table 4. Prompt to choice of strategy in the study area**

S/N	Adaptation strategy	Prompt to choice of strategy							
		No response		Climatic condition		Mixed Conditions (Climate & Land)		Indigenous knowledge	
		Freq	%	Freq	%	Freq	%	Freq	%
1	Crops adaptable to the pattern of climate i.e. Use cultivars that suit climate	7	4	173	96				
2	Use improved crop variety					180	100		
3	Intercropping			36	20	144	80		
4	Multicropping to survive adverse climate	11	6			169	94		
5	Mulching	150	83			30	17		
6	Plant cover crops	140	78	20	11	20	11		
7	Fertilizer usage	64	36			116	64		
8	Organic manure usage	167	93			13	7		
9	Combined usage; Fertilizers & organic manure	126	70			54	30		
10	Change time to plant/ sow	9	5	161	89	10	6		
11	Change tillage operations	90	50	90	50				
12	Change planting pattern	21	12					159	88
13	Plant trees to shade	157	87	23	13				
14	Plant insect resistant crops	113	63	67	37				
15	Modern technology: Extension Agents' advice	180	100						
16	Appease the gods of the land	180	100						
17	Do nothing	180	100						
	Totals	1595	52	570	19	736	24	159	5

Source: Researcher's field survey data, (2013)

**Table 5. Respondents' perception of effectiveness of strategies to solving**

Nature of problem	Respondents' perception			
	No (not persistent)		Problem persist	
	N	%	N	%
Erosion	113	16	67	36
Flood	133	19	47	26
Drought	172	24	8	4
Pest	139	19	41	22
Pilfering	159	22	21	11
Total	716	80	184	20

N/B: N = Frequency of respondents; % = Percentage; Source: Result of researchers' data analysis, (2013).

persistence of the problems with farming after adoption of the coping strategies, leaving 80% to expectedly either having no problems or already practicing the already known adaptive strategies and having good yield. It is easy to see that among the various problems encountered, the adaptation strategies adopted have helped farmers to ameliorate the situations and therefore being able to cope with the prevailing conditions.

According to the farmers in the study area, planting pattern also involves sowing time. They posit that proper sowing time and planting pattern are of great importance. They also explained that early sowing of some crops invites a large number of insect's pests and diseases while late sowing fetches lesser grain yield due to short growing season and ultimately lesser accumulation of photosynthesis as in [51]. Also, timely sowing produces taller plants with better yield and yield components especially in crops such as Maize and Okro and so on. This is derived mostly through their indigenous (local or traditional) knowledge. According to the farmers, planting pattern differs significantly from one crop to the other. For example broadcasting is still the principal method of raising Okro (*Abermosaus exilentus*), which is one of the major yield limiting factors. This agrees with the findings of [52]. Planting pattern thus influences the environmental conditions required for plants growth [53].

## 6. CONCLUSION

The study showed erosion and flood as having the most adverse situation encountered by the farmers in the study area where it thus revealed six (6) most prevalence adaptive strategy used by the farmers in the changing climate situation. Crop varieties that are improved also used by farmers as a strategy to boost yield cushions the effect of climate variability, the reason why all the farmers choose to use this method. Moreover, improved crop varieties are resistant to pests and diseases and which reduce crop loss.

These counter measures are as follows: multicropping with 93% of farmers adopting this strategy as one of the sustainable system in combating climate variability. Others include use of improved crop varieties, application of fertilizers, planting crops adaptable to the pattern of climate, intercropping and change in planting pattern respectively. However, multi cropping and the use of improved crop varieties were very outstanding. Indeed, to achieve sustainable agriculture, indigenous knowledge and adaptive mechanism within their domain of experience is vital for achieving sustainable development. Farmers can reduce the potential damage by making tactical responses to these changes. Effectiveness of adaptation strategy also requires improved indicators to monitor performance. This is necessary to improve the successful outcomes and enhance greater opportunity for more success rather than depending purely on technology such as hybridization, biotechnology, land and water management technology and mechanized farming etc. Collaboration and synergy between different stakeholders is therefore important.

## 7. RECOMMENDATION

From the foregoing, it is recommended that:

- The ideal partnership, which pairs indigeno us/ local knowledge of the city farmers with scientific research on how to boost food production amidst climate change, will be useful.
- Development of varieties and hybrids that would allow separation in time of critical development phases from the limiting environmental factors, particularly rainfall, affecting productivity.
- Promotion of low-cost adaptation technology such as organic agriculture and biotechnology
- Adequate support for agricultural research to gain more insight into the farmers knowledge and effectiveness of the

- strategies in coping with the changing environment
- Effectives monitoring and evaluation is necessary to assess the performance of the coping strategy and replication in other areas
  - There is also need to develop and promote appropriate technologies that will improve productivity of this system such as biotechnology.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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