ASSESSMENT OF FAMERS` ADAPTATION STRATEGIES OF CLIMATE VARIABILITY: IMPLICATION ON ARABLE CROPS YIELD IN OGOJA AGRICULTURAL ZONE (NORTHERN) CROSS RIVER STATE, NIGERIA

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ABSTRACT. Assessment of Famers` Adaptation Strategies of Climate Variability: Implication on Arable Crops Yield in Ogoja Agricultural Zone (Northern) Cross River State, Nigeria. The study assessed farmers' adaptation strategies of climate variability and implication on arable crops yield in Ogoja agricultural zone. Data collection procedure adopted for this study was the used of structured questionnaire, interview and focal group discussion. Four hundred copies of questionnaires were administered and three hundred and eighty eight were retrieved. The result revealed that the following adaptation strategies indicated that changing crop types /improved varieties has 70.6 percent negative and 29.4 percent positive respondent, soil and water conservation with 76.3 percent negative and 37.4 percent positive, changing planting time 62.6 percent negative and 37.4 percent positive respondent, cropping mixture or mixed cropping 32.2 percent negative and 67.8 percent positive, supplementary irrigation 55.9 percent negative and 44.1 percent positive respondent, mulching 30.2 percent negative and 69.8 percent positive, planting distance 68.0 percent negative and 32.0 percent positive, regular weeding 69.3 percent negative and 30.7 percent positive, planting trees 30.9 percent negative and 69.1 percent positive respondent ,early planting season with 41.2 percent negative and 58.8 percent positive and late planting season recorded 61.9 percent negative and 38.1 percent positive respondent. Relevant recommendations were made which includes that government should provide access to credit facilities to farmers. Besides crops that have natural adjustment potentials to climate oscillation should be cultivated and promoted. Finally, sustainable indigenous crops species with high yield and low risk as well as environmental education should be adapted.

Keywords: Famers, Adaptation Strategies, Climate Variability, Arable

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1. INTRODUCTION

Adaptation strategy has been globally recognized as an important component of climate variability impact and assessment. It is one of the policy options available with regards to response to climate change impact (Smith and Lenhart ,1996). Adaptation is a preemptive adjustment made to human ecological or physical system in response to apperceived vulnerability and external stimuli. In specific terms, IPCC (2001) described adaptation relating to climate variability as adjustment and modification in natural or human system in response to perceived or actual climate stimuli and their effect. Adaptation to variability of climatic parameters such as temperature, rainfall and relative humidity are therefore critical and of serious concern. Adégnandjou et al. (2018) believes that climate change exerts serious effect on agriculture and and other life sustaining activities. He added that farmers encounter with climate change is responsible for the increase in land degradation,

In African countries particularly Nigeria, vulnerability of adaptation is high because ability to adapt is low (Hassan & Nhemachem, 2002). In agriculture, adaptation help farmers achieved their food, income and livelihood security objectives in the face of changing socio-economic condition including climate variability, extreme weather conditions such as drought and flood, volatile short term changes in local and large scale markets (Kandlinkar & RISbey, 2000). Farmers can reduced the potentials damage to crops such as cassava, yam, maize and rice among others by making tactical response by this changes (adaptation). According to Brussel (2009), adaptive measures to climate variability in agriculture range from technological solution to adjustment of farm management or structures to political changes such as adaptation plans. Barry & Mark (2002) categorized agricultural adaptation options into technological development, government programmes and insurance, farm production practices and farm financial management. These will ultimately require well planned strategies based on accurate analysis of both local and regional conditions (Brussel 2009). It is good to note that the practice of organic agriculture is one of the most important dimensions for adaptation to climate variability by farmers at certain levels. Organic agriculture according to IFOAM (2004) is a comprehensive approach to production management that uses scientific and traditional knowledge to improve the health of agro-ecosystems. Because of its high organic matter content and soil cover, it prevents nutrient and water loss, increasing the soil's resistance to drought, flooding, and other processes that degrade land. The main methods used in organic agriculture to preserve soil fertility are internal farm inputs (generation of organic manure, legumes, and extensive crop rotation) and the rejection of energy-demanding synthetic fertilizers and plant protection agents that utilize little to no fossil fuel. (FAO 2008).

As a comprehensive method of coping with climate change, organic agriculture may be divided into two main categories of production system alteration. Enhanced diversity and safeguarding many delicate growth phases through crop management to prevent these crucial phases from coinciding with extremely severe weather circumstances, like mid-season drought (Hassan & Nhemachem 2002). Under these two modification techniques, the adaptation strategies farmers perceived as appropriate include crop diversification using different crop types and varieties, planting dates, harvesting dates, increasing the use of irrigation, increasing the use of water and soil conservation techniques, shading and shelter, shortening the length of the growing season and farmers who are unable to adapt diversify from farming to non farming activities. Strategies that serves as an important form of insurance against rainfall variability are: increasing diversification by planting crops that are drought tolerance and resistance to temperature stresses, taking full advantage of the available water and making efficient use of it, growing varieties of crops (yam, cassava, maize and rice) among others on various plots, lowering the possibility of crop failure because the effects of climate variability vary depending on the crop (Bhutan, 2006)

Kurukwasurye &Rosental (2003) noted that farmers use crop insurance to cover risks, crop diversification to boost yield, and disease prevention as short-term adaptation strategies for climatic unpredictability, adjusting the timing of farm operation to reduced risk of crop damage, change crop intensity to new climate conditions, food reserved and storage as temperature relief, changing cropping mixture and permanent migration to diversify income opportunities. On a long term note, there stated the following as the best adaptation options for climate variability :development of crops technology adapted to climate stress ,develop market efficiency ,irrigation and water storage expansion ,efficient water use, improving forecasting mechanism ,institutional strengthening and decision making structures.

Brussel (2009) highlighted the possible short term medium to adaptation strategies to variations in climate by farmers to include: adjusting the timing of farm operations such as planting or sowing dates and treatment, choosing crops and varieties better adapted to the expected length of the growing season and water availability and more resistant to new conditions of temperature and humidity, adapting crops with the help of existing genetic diversity and new possibilities offered by biotechnology ,using water more efficiently by reducing water loses and improving irrigation practices and recycling or storage water, improving the effectiveness of pest and disease control for instance better monitoring diversification crop rotations or integrated pest management method. Individually or the combination of these adaptation strategies by farmers have substantial potentials to counterbalance adverse climate variability and to take advantage of positive ones.

In Cross River State Nigeria particularly, the north-east of the state, the most crop farming are rain fed ,thus rainfall being the most important element of climate Adejuwon (2006), a change which could greatly affect crops farming in the country. This study reveals that arable crops farmers are likely to be more severely affected because of their lack of adaptive capacity to climate variability and change (Mertz, et al, 2009)

Good agricultural management practices have the potential to build the basis for effective climate adaptation methods and the indigenous knowledge strategies should be used in conjunction with the scientific knowledge system for impact reduction (Morton, 2017). When crop yields are low, due to losses as a result of climate variability as evidenced in changing times for the start and stop of rainy (growing) and dry seasons, farmers pay dearly for their ignorance or unpreparedness to capacity to cope.

Rural farmers' awareness of climate variability, its impacts, and their specific adaptation measures, are valid starting point for science driven assessments, for appraising the climate trend. This was based on the general objectives of assessing how farmers' perception of climate variability closely mirrors the climatic trend from the scientific meteorological analysis. An inept understanding of climate variability among the rural arable crop farmers in northern Cross River would be very useful for better adaptation of strategic planning which will later improve planning scheme in agriculture and other economic sectors. Asravor, R.K. (2022) believes that inadequacy of capacity building program is the major availability constraint, whereas, inadequacy of the required funds to purchase inputs such as fertilizer is the major liquidity constrain

2. THE STUDY AREA

The study was conducted in Ogoja agricultural zone of northern region cross river state, located in the South South Nigeria. The area is made up of five local government comprises of Bekwara local government, Obudu local government, Obanliku local government, Ogoja local government and Yala local government. Benue State to the north, Ebonyi State to the west, the Republic of Cameroun to the east, and Ikom and Boki local government of Cross River State to the south define the boundaries of the area.(Fig 1).

The nature of the soil found in the Northern Cross River differs in their physico-chemical characteristics. It varies from brownish yellow to yellowish red and the texture varies from sandy clay to clay subsoil. The soil PH ranges from 5.0 and below with cation exchange capacity less than 10meg/100g (Afu, 2013). The soil mention above is common in Bekwara, Yala and part of Obudu and Ogoja. The mountain soil of Obudu has 44 to 98 percent and,10 to 26 percent silt and 10 to 44 percent clay (Essoka, et al. 2009). This soil are acidic with mean PH ranging from 4.52 to 5.93 and can be used for arable crops, tree crops or forest species (Essoka .and Essoka 2014).The type of arable crops planted or grown in the

area are yam, cassava, rice, maize, groundnut pineapple ,soya beans, cocoyam, pumpkin, melon, and okra among others (Afu, 2013).

Climatic information data obtained from the meteorological centre Ogoja that covers the entire Ogoja agricultural zone (northern) cross river for temperature, rainfall and relative humidity. State that climate varies within the zone. Temperature varies from 22.25 0c to 28.32 0c, rainfall varies 1251.40 mm to 3347.30 mm, relative humidity varies 71.00 percent to 75.00 percent annually, which reveals that both monthly and daily climatic conditions also vary.

Topography of the study area maintains with the altitudes of 1300 to 1400m in Obudu and Obanliku local government area. Bekwara, Ogoja,and Yala local government area has lowland with small areas with undulating land with elevation of 150 to 300m.The are many rivers formation taking their source from Obudu rivers, Obudu ranch water fall, Abakpa river, Monaya river, Ishiaya river,Igbodor river and Ikangdanga river (Afu, 2013).

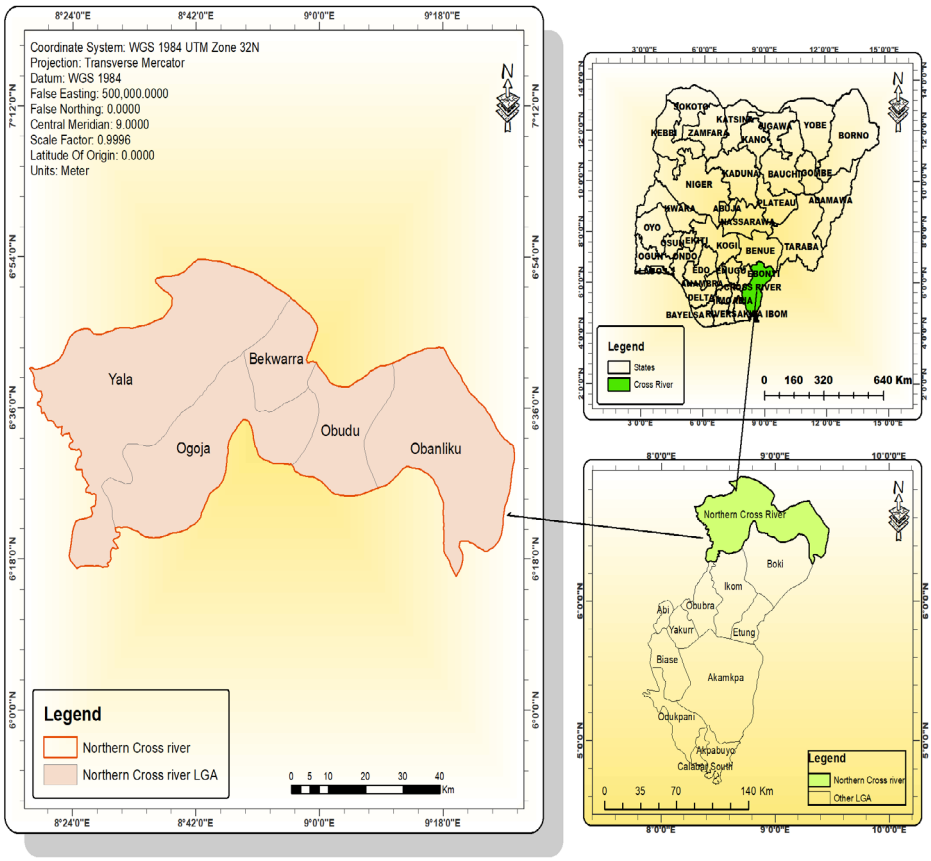

Fig.1. Map of the Study Area

Source: Authors fieldwork

3. METHODOLOGY

The study was carried out in ten communities of the five local government area representing Ogoja agricultural zone of cross river state. The local government areas include Bekwara local government, Obanliku local government, Obudu local government, Ogoja local government and Yala local government areas. Two (2) communities were adopted by the used of table of random numbers selected from each local government for questionnaire survey and interview. The questionnaire survey was carried out on registered arable crop farmers to generate data on adaptation strategies of climate variability on arable crop yield.

The field information from the questionnaire survey was supplemented with more details using participatory rural appraisal methods. The tools such as checklist, semi structured interview, participatory observation and focal group discussion provided the background information on farmers adaptation strategies of climate variability on yield of crops in Ogoja agricultural zone of cross river state. The total number of registered farmers in each community such as Ukpa and Ibiaragidi(Bekwara), sankwala and Lishiche (Obanliku), ukprinyi and Ukpada(Obudu),odajie mbube and ishibori (Ogoja), imaje and ebo walache (Yala local government area). 823 arable crop farmers were generated in 2015 and the data of the figures were gathered from local government extension officers of cross river state agricultural development project (CRADP) in each of the local government under studied. Out of the total number of (400) four hundred questionnaire administered, (388) three hundred and eighty eight were returned. The questionnaire represent about 48 percent of the total of 823 in the ten sample villages were systematically sampled.

4. RESULT AND FINDINGS

Climate variability obviously is a challenge to farmers in Cross River State and Ogoja agricultural zone is not exceptional. This is because farmers' practices of adaptation strategies in the zone are unable to predict increase harvest of arable crops.

The following are the adaptation strategies adopted in the zone. Changing crop types/improved varieties, soil and water conservation, changing planting times, mixed cropping, supplementary irrigation, mulching, planting distances, regular weeding, planting trees ,early planting season ,and late planting season.

Based on the findings of adaptation of changing crop types/improved varieties, respondents on the questionnaire was on the validity of positive and negative, the validity of negative recorded 70.6 percent and positive 29.4 percent. (Table 1).Which means that farmers continue to cultivate the same crop type and varieties from year to year instead of crop yield to increase, they continue to produce same harvest without increase yield stability. Farmers further revealed

that few of them who adapted by the situation of effecting changes in varieties and crop types experience increase in crop yield because the previous species used has been so used to climate conditions of the environment, thereby causing yield decrease. The study found out that extension officers have significant influence on farmers' choice of growing varieties of arable crop types, but the ability to find them around to educate them is difficult. Discussion with farmers further indicated that the more years a farmer adds, the more the level of experience on the type of crop varieties to grow. Therefore adaptation to changes of crop types and climate variability can improved arable crops yield in Ogoja agricultural zone of Northern Cross river state.

Soil and water conservation adaptation to climate variability on arable crops yield are those activities at the local level which maintain or enhance the productive capacity of the land including vegetation, water and soil in areas prone to degradation through reduction or prevention of soil erosion, compaction, salinity, drainage or conservation of water and improvement or maintenance of soil fertility (WOCAT. 2007). Measures of soil and water conservation adaptation are predominantly applied by farmers to control run off and thus prevent loss of soil by soil erosion on farm land and reduced soil compaction to improve or maintain fertility for farmers to increase crops yield ,to conserve or drain water and to harvest (excess) water Though percentage of negative and positive respondents from the questionnaire indicated 76.3 percent negative and 23.7 percent positive (Table 2).Its further revealed that famers are aware of soil and water conservation although the ability to adapt was a challenge.

Table 1: Changing crop type/improved varieties

Valid	Frequency	%	Valid %	Cumulative %
No	274	70.6	70.6	70.6
Yes	114	29.4	29.4	
	388	100.0	100.0	

Source: Authors fieldwork

Changing planting time as adaptation strategies in Ogoja agricultural zone revealed that the inability for crops to improve yield is due to erratic rainfall and unfavourable temperature which implies that crops that were grown late encountered abrupt stoppage of rainfall and high temperature. This resulted into lack of adequate water for proper crop growth and maturity. From the validity percentage of the questionnaire of positive and negative respondents administered to farmers ,positive represented 37.4 percent and negative 63.6 percent.(Table 3) which shows that farmers practice changing of planting times or date but inadequate.

Table 2: Soil and water conservation

Valid	Frequency	%	Valid %	Cumulative %
No	296	76.3	76.3	76.3
Yes	92	23.7	23.7	100.0
	388	100.0	100.0	

Source: Authors fieldwork

Table 3: Changing planting time

Valid	Frequency	%	Valid %	Cumulative %
No	243	62.6	62.6	62.6
Yes	145	37.4	37.4	100.0
	388	100.0	100.0	

Source: Authors fieldwork

Mixed cropping is another adaptation strategies that is practice in the zone, which include mixed intercropping, strip (row) intercropping and relay intercropping are important in both traditional and modern agriculture has revealed by extension officers and farmers that mixed cropping is the oldest traditional type of farming, that most of the farmers practice these strategies because it saved land ,pest control, disease and can tolerate climate variability. From the questionnaire, indicated 67.8 percent positive and 32.2 percent negative respondent which revealed that more farmers adapted to mixed cropping in the zone. (Table 4)

Table 4: Crops mixture

Valid	Frequency	%	Valid %	Cumulative %
No	125	32.2	55.9	55.9
Yes	263	67.8	44.1	100.0
	388	100.0	100.0	

Source: Authors fieldwork

Adaptation of supplementary irrigation through harvested rainfall water in excavated or embanked type of reservoirs, this type of farming is the combination in dry land and limited irrigation is an ideal choice of improving crop yield in the zone (Bai. & Dong 2001). This system is highly beneficial in supplying water during period of shortfalls of rain to provide essential soil moisture to secure harvest. The farmers revealed that the validity percentage from the questionnaire indicated positive 44.1percent and 55.9 percent negative, which indicated that more farmers were unable to adapt to supplementary irrigation in the zone.(Table 5).

Table 5: Supplementary irrigation

Valid	Frequency	%	Valid %	Cumulative %
No	217	55.9	55.9	55.9
Yes	171	44.1	44.1	100.0
	388	100.0	100.1	

Source: Authors fieldwork

Adaptation to mulching is being used as the process of covering the open surface of the ground by a layer of some external materials, the materials used in covering is called mulch as stated by farmers. It is used to retain moisture in the soil, suppress weeds, keep the soil cool, prevent frost heaving in winter and make the garden bed look more attractive. Organic mulches also help improved the soil structure, drainage and nutrient holding capacity as the decomposed as revealed by the farmers. It was further indicated from the questionnaire that positive indicated 69.8 percentage and negative indicated 30.2 percent (Table 6). Which state that more farmers adapted to mulching in the zone.

Table 6: Mulching

Valid	Frequency	%	Valid %	Cumulative %
No	117	30.2	30.2	30.2
Yes	271	69.8	69.8	100.0
	388	100.0	100.0	

Source: Authors fieldwork

Adaptation to planting distance is a practice of spacing your plant appropriately to reduced the risk of disease .It is easy for disease to spread from one plant to another if the plant are growing together, so plant growing too closely together are not as healthy as plant with enough space according to farmers, it was further revealed that planting distance can increase yield, ease harvest ,increase nutrient intake, ventilation of atmosphere, free flow of water and management of weeding can take place easily. Climate variability of arable crop plant can be affected if farmers are unable to practice the strategy of planting distance, though few farmers are able to adapt from the positive and negative questionnaire, positive indicated 32.0 percent and negative indicated 68.0 percent in the zone.(Table 7).

Adaptation to regular weeding is one of the activities performed as soon as weed emerge from the soil to prevent them from developing large roots system and keep the soil free of invading plants, because small seedlings have shallow roots systems which can be easily damaged .Though farmers revealed that most

of them still adapt to their old tradition of weeding between two to three times per season instead of weeding regularly. Very few farmers weed their crops regularly, the questionnaire revealed that positive from the respondents was 30.7percent while negative indicated 69.3percent.(Table 8).Which means that as it continue to rain without regular weeding due to climate variability, crops yield will continue to decrease .

Table 7: Planting distance

Valid	Frequency	%	Valid %	Cumulative %
No	264	68.0	68.0	68.0
Yes	124	32.0	32.0	100.0
	388	100.0	100.0	

Source: Authors fieldwork

Table 8: Regular weeding

Valid	Frequency	%	Valid %	Cumulative %
No	269	69.3	69.3	69.3
Yes	119	30.7	30.7	100.0
	388	100.0	100.0	

Source: Authors fieldwork

Adaptation to planting trees are our main survival tools, only one tree can produced enough oxygen for three or more people. Trees serve as natural air conditioning, saving water, purify air, serves as carbon sequestration, control flood, provide wildlife habitat, provide mental health, control temperature, preventing water pollution, reinforcing soil and renewable energy source. Farmers revealed that the awareness of planting trees was already established through extension officers, that naturally they know the impact of trees on the environment. Therefore, the questionnaire administered to the respondents further indicated that farmers adaptation to planting trees are more with 69.1percent positive and 30.9percent negative (Table 9).

Table 9: Planting trees

Valid	Frequency	%	Valid %	Cumulative %
No	120	30.9	30.9	30.9
Yes	268	69.1	69.1	100.0
	388	100.0	100.0	

Source: Authors fieldwork

Adaptation to early planting season as a strategy of climate variability on the yield of arable crops from the questionnaire ,respondents indicated positive 59.8percent and negative 41.2percent (Table 10) which revealed that farmers adapted more in early planting season because of the early rain and in late

planting season respondents indicated 38.1 percent positive and 61.9 percent negative (Table 11)which demonstrated that farmers are few in numbers who adapted to late planting season in the zone.

Table 10: Early planting season

Valid	Frequency	%	Valid %	Cumulative %
No	160	41.2	41.2	41.2
Yes	228	58.8	58.8	100.1
	388	100.0	100.0	

Source: Authors fieldwork

Table 11: Late planting season

Valid	Frequency	%	Valid %	Cumulative %
No	240	61.9	61.9	61.9
Yes	148	38.1	38.1	100.0
	388	100.0	100.0	

Source: Authors fieldwork

According to respondents to climate variability in the zone, 92 (23.7%) of the respondents do not adjust at all to climate variability, according to Table 12.Furthermore, 137 (35.3%) and 142 (36.6%) percent respectively adapted somewhat and moderately well. Six (1.5%) and 11 (2.8%) of the responders, respectively, adapted to climate variability extremely well and exceptionally well. The research revealed that the majority of respondents (142, or 36.6%) who selected the moderate adaptation option to climate variability did so fairly, indicating that more respondents overall adapted to climate variability on the yield of arable crops in Ogoja agricultural zone.

5. RECOMMENDATIONS

- Access to credit facilities to farmers because in order to make purchase of advanced technologies, improved adaptation measures to cope with climate variability.
- It is recommended to develop and support crops with high natural adjustment potentials to climate oscillations and soil fertility.
- The zone should support native agricultural species that are high yielding but low risk, and that have demonstrated resistance to pests, diseases, droughts,

Table 12 Respondents' adaptation strategies to climate variability in Ogoja agricultural zone

Adaption to all climate change		**Ogoja**	**Bekwarra**	**L.G.A Yala**	**Obudu**	**Obanliku**	**Total**
Not at all	Count percentage	21	12	31	12	16	92
	Within adaption to climate variability	22.8	13.0	33.7	13.0	17.4	100.0
	Percentage within LGA	26.3	14.6	43.7	16.9	19.0	23.7
	Percentage of total	5.4	3.1	8.0	3.1	4.1	23.7
Slightly well	Count	34	32	23	28	20	137
	Percentage within Adaption to climate variability	24.8	23.4	16.8	20.4	14.6	100.0
	Percentage within LGA	42.5	39.0	32.4	39.4	23.8	35.3
	Percentage of total	8.8	8.2	5.9	7.2	5.2	35.3
Moderately well	Count	25	36	16	26	39	142
	Percentage within Adaption to climate variability	17.6	25.4	11.3	18.3	27.5	100.0
	Percentage within L.G.A	31.3	43.9	22.5	36.6	46.4	36.6
	Percentage of total	6.4	9.3	4.1	6.7	10.1	36.6
Highly well	Count	0	0	1	2	8	11
	Percentage within Adaption to climate variability	0.0	0.0	9.1	18.2	72.7	100.0
	Percentage within LGA	0.0	0.0	1.4	2.8	9.5	2.8
	Percentage of total	0.0	0.0	0.3	0.5	2.1	2.8
Very highly well	Count	0	2	0	3	1	6
	Percentage within Adaption to climate variability	0.0	33.3	0.0	50.0	16.7	100.0
	Percentage within LGA	0.0	2.4	0.0	4.2	1.2	1.5
	Percentage of total	0.0	0.5	0.0	0.8	0.3	1.5
Total	Count	80	82	71	71	84	388
	Percentage within Adaption to climate variability	20.6	21.1	18.3	18.3	21.6	100.0
	Percentage within LGA	100.0	100.0	100.0	100.0	100.0	100.0
	Percentage of total	20.6	21.1	18.3	18.3	21.6	100.0

Source: Authors fieldwork

and floods. If crop yield increased, this would elevate the rural farmers' socioeconomic standing.

- The government should see to it that farmers receive extension services, including information on current farming issues, new technological developments for farming related to climate variability issues, and training on new agricultural techniques to counteract climate variability and change effects in farming. Farmers should be visited on a regular basis.
- Introduction and application of full irrigation in light of agriculture's excessive reliance on precipitation-fed water.
- Extension agents and elementary and secondary school curricula should incorporate environmental education (adult) to farmers in order to raise their knowledge and awareness of environmental threats and degradation.

6. CONCLUSION

Farmers' adaptation strategies of climate variability and implication on the yield of arable crops in Ogoja agricultural zone (northern) Cross River State has been obviously challenging. Farmers adoption follows the strategies below: Changing crops type/varieties from the questionnaire of positive and negative respondents indicated 70.6 percent negative and 29.4 percent positive, soil and water conservation indicated 76.3 percent negative and 23.7 percent positive, changing planting time 62.6 percent negative and 37.4 percent positive, mixed cropping 32.2 percent negative and 67.8 percent positive, supplementary irrigation 55.9 percent negative and 44.1 percent positive ,mulching 30.2 percent negative and 69.8 percent positive ,planting distance 68.0 percent negative and 32.0 percent positive ,regular weeding 69.3 percent negative and 30.7 percent positive, planting trees 30.9 percent negative and 69.1 percent positive, early planting season 42.2 percent negative and 58.8 percent positive ,and late planting season 61.9 percent negative and 38.1 percent positive. Overall, the study found that, out of all the respondents, 142 (36.6%) had a moderately good level of adaptability to climate fluctuation. This showed that in the Ogoja agricultural zone (northern Cross River State), a higher proportion of farmers have fairly adapted to climate variability on arable crops.

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