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How Do Arable Crop Farmers' Adapt to Climate Change? New Evidence from Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors ENS, OKC, BOS, JA and NJC did the conceptualization. Data collection and collation was done by authors RPE, ASN, RRR, OUN and APC. Authors ENS, APC, ASN, VM and RRR did the methodology and formal analysis. Authors ENS and CCI wrote the original manuscript and prepared the draft. Authors ASN, RPE, VM, BOS, ENS, APC, VM and EP did the visualization. Authors ENS and BOS supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

In Nigeria, climate change is not a new phenomenon and arable crop production is vulnerable to climate change. Arable crop farmers have always responded to climate change with local strategies believed to be climate-smart. Arable crop farmers' knowledge of climate change is an important step in understanding any action to be taken to reduce its effect. However, empirical studies on the link between climate change and crop farmers' adaptation strategies are still relatively scanty in the area. This presents a dearth in research. Therefore, our paper examined how arable crop farmers adapt to climate change using cross-sectional data obtained through a structured focused group discussion and questionnaire from 120 arable farmers across critical farming communities in Imo State, Nigeria. We utilized multistage and purposive sampling procedure in the selection of arable crop farmers. The reason we utilized purposive sampling procedure was to select areas with high intensity of arable crop farmers and farming. Data collected was analyzed using descriptive statistical tools and mean ($\bar{x}$) score analysis. Our result shows that the mean age was 42.00 years. Greater proportions (73.00%) were female. The average farm size was 1.45 hectares. Vegetables (100.00%), maize (99.17%), cassava (98.33%) and rice (96.67%) were among the crops produced in the area. The result confirmed the incidence of climate change in the area and farmers perceived rightly the direction of the change, which includes declining crop yields ($\bar{x}$ = 3.00; σ = 0.50), increased in new pests and diseases infestation ($\bar{x}$= 2.88; σ = 0.58); unstable decrease and increase in temperature and rainfall ($\bar{x}$=3.63, σ = 0.83) among others. Our study further shows that the major climate change adaptation measures farmers practiced were diversification of livelihood (99.17%) and changing planting/harvesting dates (97.50%). Farmers identified inadequate information (99.17) and inadequate climate change adaptation fund (98.33%) among others as the barriers they faced in adapting to climate change in the area. We recommend that, since arable crop farmers are members of cooperatives, they are encouraged to take advantage of their strength to collectively project a common demand in obtaining funds and other necessary inputs in adapting to climate change in the area. Finally, our study also suggests that the agricultural extension service system should be strengthened so as to provide farmers with stable and right early warning signs which will be critical in minimizing risks of climatic threats in the area.

Keywords: Arable crop; climate change; adaptation strategies; perceived effect; barriers and Nigeria.

1. INTRODUCTION

Half the world consumes arable crops such as rice, yam, bean, maize, and cassava, among others [1]. In Nigeria, every household consumes it. The large and densely populated nation is facing the worse climate crises across sectors, but particularly in agricultural sectors [2]. The impact of a changing climate on arable crops is a catastrophe shared by many countries in the Global South, from Sub-Saharan Africa (SSA), where biodiversity-based rice and cassava farming is facing extinction, to the northern part of Nigeria, where drought and flood disaster is destroying agrifood systems [3]. Presently, the international community is faced with the problem of limiting the harm caused by climate change. Mitigation and adaptation to climate change are critical in this regard. Also while adaptation can help control the effects, it cannot address climate change on its own [4]. "There will always be ongoing expenses notwithstanding adaptation. For example, arable crop farmers in Nigeria may be able to move to crop types that are more suited and well acclimated to climate change, but their productivity may suffer as a result. The arable crop sector in Nigeria must adapt to the changing environment in order to sustain the livelihoods of the impoverished and increasing populations. A variety of stakeholders, including legislators, extension agents, nongovernmental organization (NGO), International non-governmental organization (INGO), researchers, communities, and farmers, will need to be included in the adaptation process. Arable crop farmers' knowledge of climate change is an important step in understanding any action to be taken to reduce its effect" [5]. "The success of climate change adaptation is also location-specific and is influenced by the socioeconomic and institutional context of the area" [6]. Rainfed agriculture, which is extremely susceptible to climatic unpredictability and change, is the main source of production for arable crop farmers in Nigeria [7]. "Arable crop farming has been impacted by changes in the distribution and volume of rainfall, which have led to low precipitation, flooding and recurrent droughts" [8]. Empirical studies on the link between climate change and crop farmers' adaptation strategies are still relatively scanty in the area. This presents a dearth in research. Therefore, the absence of this study creates a void in research and makes it increasingly pertinent that the study is systematically undertaken. Hence, the specific objectives of the study were to (i) describe the socio-economic characteristic of the arable farmers in the study area (ii) ascertain farmers perceived effect of climate change on arable crop farming; (iii) describe arable crop farmers' adaptation strategies to climate change (iv) and identify barriers of arable farmers in adaptation to climate change.

2. MATERIALS AND METHODS

The study was carried out in the Southeast agricultural zone of Nigeria from September through December, 2023. "The zone is made up of five States, namely, Abia, Anambra, Ebonyi, Enugu and Imo. It has an estimated land mass of 32,610 km2 and a population of 22,583,076" [9]. "The area lies between longitude 2o611 and 60.321 East and latitudes 6o741 and 8o151 North of the Equator with the mean annual temperature ranging from 21.6oC to 32.4oC while the annual rainfall ranges from 720 mm to 1440 mm in the rainforest region" [9,10]. The State has good climatic conditions suitable for arable crop production and a good proportion of the population are essentially arable crop farmers. In the selection of respondents who are arable crop farmers, the study utilized multistage and purposive random sampling procedure. Selecting farmers who are primarily engaged in arable crop cultivation in the region was done through purposive sampling. One hundred and twenty (120) arable crop farmers made up the samples. The sample proportion and the map of the study were shown in Table 1 and Fig. 1 respectively. In addition, data collected were analyzed using descriptive statistics such as mean, percentage and mean score of likert scale type. The study used descriptive statistics to describe the socio- economic characteristics of arable crop farmers and mean score of likert scale type to ascertain farmers perceived effect of climate change on arable crop farming in the area. The primary instrument used to gather data was a structured questionnaire and focused group discussion (FGD). The Likert scale type rating method was used to examine the data. The weighted mean (Xw) calculation methodology was given below [11].

$$X_w = \frac{\sum_{j=1}^{5} ni(5i)}{n}$$

Where

Xw = Weighted Mean Score
n = Number of arable crop farmers selected Σ = Summation

The various attributes (climate change adaptation strategies) were rated using mean score of a 4-point Likert scale type rating model for arable crop farmers.

perceived effect of climate change on arable crop farming in the area and then divided by the number of scales to obtain the discriminating index, for example, (4+3+2+1)/4 = 2.50 cut-off point. It was stated as follows;

SA = Strongly agreed (4) A = Agreed (3)
D = Disagreed (2)
SD = Strongly Disagreed (1)

2.1 Decision Rule [11]

0.1-1.99= Minor effect;
2.0-2.49= Moderate effect;
2.50 and above = High effect; The level of Significance is 0.05%

Table 1. Sampling proportion for the arable crop farmers

Southeast Agricultural Zones of Nigeria	Total Number of Local Government	Total Number of Communities	Total number of Villages	Total Number of Farmers	Total number of farmers per zone
Ebonyi	5	5	10	4	40
Imo	5	5	10	4	40
Anambra	5	5	10	4	40
Total	15	15	30	12	120

Source: Field survey data, 2024

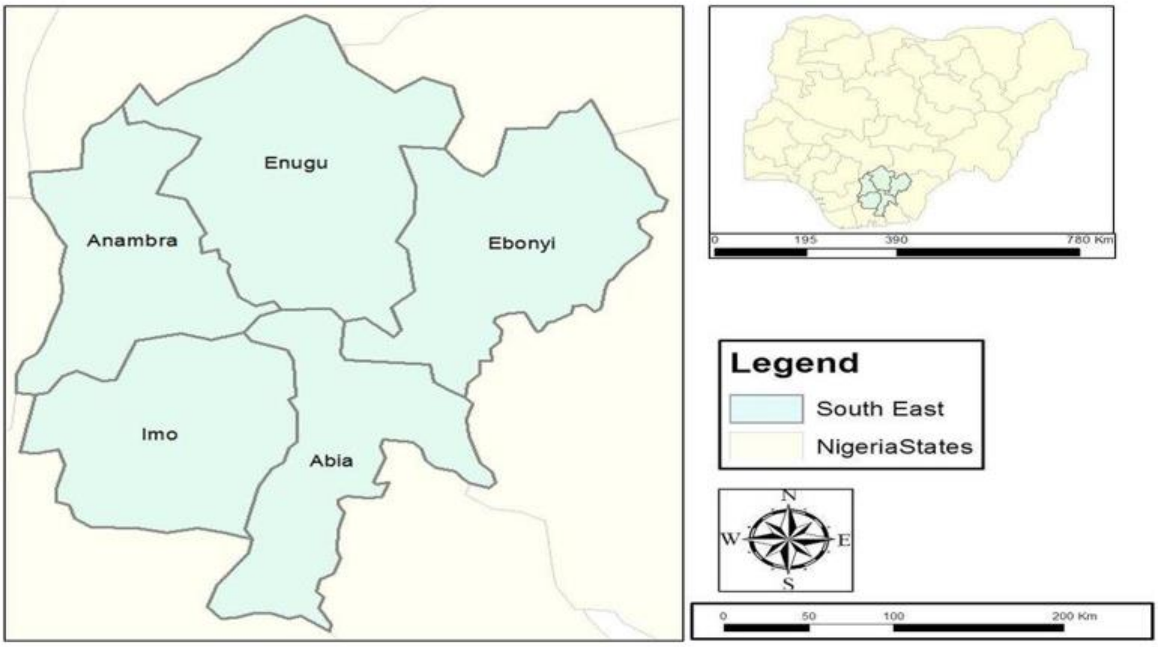

Fig. 1. Map of Southeast Nigeria showing the five various States [11]

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Arable Crop Farmers

The socio-economic characteristics of the arable crop farmers in the area were shown in Table 2. The mean age of the farmers were 42 years old. This suggests that farmers in the area are vibrant, young and still within their active age. Arable crop farming could be strenuous. This is an indication that the famers were young adults who were full of energy to provide what is needed in climate change adaptation and arable crop farming in the area. The implication is that younger farmers are likely to practice more and modern climate change adaptation strategies faster than the older ones. The finding is in line with the study of Danso-Abbeam et al. [12] who reported that “young farmers are more likely to know and practice new adaptation strategies to avert climate change impact with the willingness to bear risk due to their wide network, planning, energy, enthusiastic and information horizon. Greater proportions 0.73 (73.00%) of the arable crop farmers were males”. This implied that both sexes (male and female) are involved in arable crop farming but males were more in number.

Nigeria has a more paternalistic culture, which makes it simpler for men than for women to acquire and own productive agricultural inputs, such as land, funding, improved seedlings, and labor. This may also be explained by the fact that producing arable crops in the research region involves a lot of labor-intensive tasks. But it was thought that women were more active in agricultural product processing and marketing. Furthermore, male farmers may be more resilient to the strains and stresses of growing arable crops as well as the adverse effects of climate change. This supported the findings of Esiobu et al. [6,13], who found that “in a research on the barriers to climate variability adaptation in Nigeria, men predominated in agricultural output”. The average household size in the area was 7 persons, suggesting that the arable crop farmers had quite high households, some of which may have included direct family, relatives, or extended dependents who could help with farming production and practice more climate change adaptation strategies in the area. The result was in consonance with the study of Ayanlade et al. [14], who found that “household size could be a proxy for labour to increase and enhance their farming activities, climate change adaptation and expansion of farm income”. The average length of time spent in school was 12 years, which suggests that the arable crop farmers in the region had at least a secondary education. Education could be very positive in influencing arable crop farmers’ climate change adaptation strategies for increasing yield in the area. The finding was consistent with the result of Esiobu et al. [15], who asserted that “higher education influences farmer’s decision making positively, acceptance of innovation, better access and utilization of productive input in adapting to climate change impact in agrifood system". The extension values of 0.25 (25.00%) and 2.00 revealed that about 25% of the arable crop farmers accessed extension services and were visited at least 2 times per year by the extension agents in the area. This is quite poor and could negatively affect arable crop farmers' adaptation to climate change in the area. Improved and steady contact of farmers with extension agents is critical in improving farmers' information, access to input, innovation resulting to high yield and income and standard of living. The result supported the findings of Esiobu et al. [15,16], who reported that extension contact improves farmers' access to recent information and expertise of contemporary farming techniques to raise their yield, income and standard of living. The average experience in farming was 16 years. This is a strong indication that arable crop farmers have reasonable years of experience in farming and may have been adapting to climate change in the area. Since climate change is yearly recurring decimals, the number of years that farming has been practiced helps to mitigate its consequences. Farmers gain exposure to a range of farm management and climate change adaptation strategies via experience, which they may use to prepare for projected climate change. Guodaar et al. [17]. A unit increase in farming experience is anticipated to boost farmers' practical expertise in resolving difficulties specific to arable crop farming and their ability to handle both internal and external obstacles influencing arable crop yield particularly related to climate change. The mean farm size of the arable crop farmers in the area was 1.45 hectares. This is characteristic of rural farmlands, which are frequently dispersed, fragmented, and small in size. This small farm size could also be attributed to the system of land tenure and urbanization predominant in the area. Land is one of the important productive inputs in arable crop farming and when farmers have limited size of it, increased farm production and adaptation to climate change may be unattainable. The finding tallies with the studies of Guodaar et al. [17,18], who found that "large farm size increases yield, farmers adaptation to climate change, and income of the farmers. Additionally, research shows that 0.68 (68%) of the arable crop farmers belonged to cooperative society". "This suggests that arable crop farmers might have access to current research and information on climate change adaptation through the cooperative society. Cooperative membership is helpful tool for members to manage risks, exchange knowledge, labour, and pool their limited resources to boost yield, income and standard of living" [19]. Finally, finding from Table 2 indicates that the mean annual farm income from arable crop production was ₦510,000.00 ($341.43). This is an indication that arable farmers have a relatively high annual farm income which could positively affect farmer's adaptation to climate change in the area. Most climate change adaptation strategies are costly [15] and farmers with sizable and sustainable farm income would be able to adapt adequately.

3.2 Arable Crop Farmers Enterprise-type

The result in Fig. 2, shows arable crop farmers distribution based on enterprise-type. The result shows that all (100.00%) the farmers were into vegetable farming. This could be because vegetable has early maturity, high market value, minimal labour requirement and could easily be intercropped with other arable crops such as yam, maize, melon and cassava, and it can be easily be planted against fence or bamboo stakes. Approximately, 99.17%, 98.33%, and 96.67% of the arable crop farmers identified maize, cassava, rice, respectively as their farming enterprise-type. The finding implies that farmers are involved in one or more form of arable crop enterprise-type. This could be because arable crop farming is vulnerable to the overall effects of climate change. "Also climate change impact encourages farmers to diversify in arable crop production in order to stabilize their food stocks and incomes. Crop diversification is based on cultivating more than one variety of crops belonging to the same or different species in a given area. Crop diversification is one way of developing a resilient agricultural system, especially where communities depend largely on agricultural products (food and fodder) for their livelihoods" [20]. The findings also support the study of Nigeria [21] who opined that crop diversification is also one of the most ecologically, feasible, cost-effective and rational ways of reducing uncertainties in agriculture, especially among arable crop farmers [22].

3.3 Arable Crop Farmers Perceived Effect of Climate Change on Arable Crop Farming

"The outcome of arable crop farmers' distribution based on perceived effect of climate change on arable crop farming in the area is shown in

Table 2. Socio-economic characteristics of Arable Crop farmers

S/No	Variables	Mean (x̄)/Percentage (%)
1	Age (years)	42.00
2	Sex (percentage of male)	0.73
3	Household size (number of persons)	7.00
4	Education (years spent in school)	12.00
5	Extension contact (percentage of access)	0.25
6	Number of extension visits (number of visits per season)	2.00
7	Farming experience (years)	15.00
8	Farm size (hectares)	1.45
9	Membership of cooperative (percentage of members)	0.68
10	Annual Farm income (Nigerian Naira)	₦510,000.00 ($341.43)

Source: Field survey data, 2024

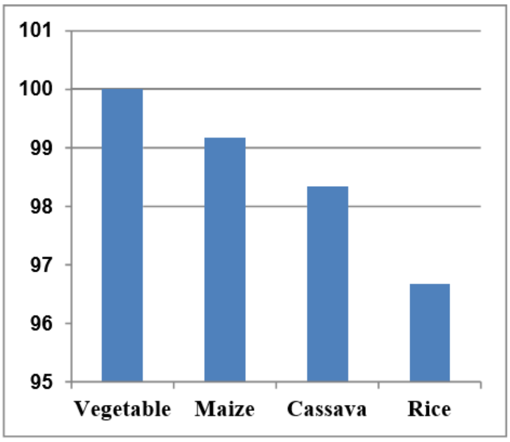

Fig. 2. Arable crop enterprise type

Table 3. The various attributes were rated on a 4- point Likert type scale rating questions of Strongly Agreed (4); Agreed (3); Disagreed (2) and Strongly Disagreed (1). The values of standard deviation (σ) denote the degree of variation in the responses of the arable crop farmers on their perceived effect of climate change on arable crop farming in the area. Farmers adaptation to climate change and reducing climate change impact in arable crop production is a critical target for many African countries (of which Nigeria is included) in order to comply with their climate policy commitments” [23]. However, understanding perceived effect and farmers' knowledge on adaptation strategies is key to achieving community, regional, and global climate policy commitments. Using the method of mean score analysis, a discriminatory mean of 2.50 was produced which divided the distribution into four scale. The mean value of each attribute equal to or above ($\bar{x} \geq 2.50$) was regarded as being an accepted decision while attributes with mean value less than ($\bar{x} \geq 2.50$) were regarded as a rejected decision. The values of standard deviation (σ) denote the degree of variation in the responses of the arable crop farmers perceived effect of climate change on arable crop farming. The standard deviation value indicates high variances in arable crop farmers response regarding their perceived effect of climate change on arable crop farming. The way farmers perceived climate variations in their environment is quite important because it significantly influence the capacity of farmers to develop appropriate adaptation strategies. From the result, arable crop farmers agreed and perceived highly that the incidence of climate change has resulted to arable crop planning and management challenges due to unreliable climate data ($\bar{x}$= 3.31; σ = 0.65); declined in crop yields ($\bar{x}$ = 3.00; σ = 0.50); increased water scarcity ($\bar{x}$ = 1.85; σ = 0.48); increased new pests and diseases infestation ($\bar{x}$= 2.88; σ = 0.58); increased in rate of erosion/flooding ($\bar{x}$= 2.78; σ = 0.55); and decreased temperature/rainfall ($\bar{x}$ = 3.63; σ = 0.83) in the area. This finding is similar [24] who noted that in Nigeria, the incidence of climate change has resulted in declining crop yield, increasing temperature and sunshine thereby affecting farmers income and standard of

living. In addition, the arable crop farmers perceived that climate change has resulted to changing from farming to non-farming activities ($\bar{x}$= 2.66; σ = 0.64); unstable decrease/increase in temperature/rainfall ($\bar{x}$= 3.63; σ= 0.83); increased cost of crop seedlings and inputs ($\bar{x}$= 2.90; σ = 0.60); declined of farm income ($\bar{x}$= 2.93; σ = 0.64) and increased distance between farms and markets ($\bar{x}$= 2.80; σ= 0.56) in the area. The result share view with the finding of Mohammadi et al. [25] who opined that rising temperatures increases the stress experienced by arable crop which further heightens the crop susceptibility to pest and diseases resulting to poor yield. However, from the aggregate mean ($\bar{x}$= 3.15; σ = 0.66) which is above the discriminatory score ($\bar{x}$≥2.50), it shows that the arable crop farmers perceived rightly the effects of climate change on arable crop production and it was therefore accepted.

3.4 Arable Crop Farmers' Adaptation Measures to Climate Change

Table 4, shows arable crop farmers' adaptation Measures to climate change in the area. The result reveals that about 99.17% of the farmers identified diversification of livelihood as one of their several adaptation options to climate change. The study of Mukoobwa et al. [26] reported that "increased diversification is a strong climate change adaptation measure". "Approximately, 97.50%, 86.67% and 85.00% of the arable crop farmers identified changing planting/harvesting dates; agroforestry practices; and intercropping of crop respectively. Adjusting planting and harvesting time enable farmers to predict the possible climatic outcome on crops farming and also helps them adapt easily to climate change. Agroforestry is a rational land-use planning system that tries to find some balance in the raising of food crops and forests" [27]. Agro-forestry and afforestation may therefore have become particularly needed because of the prevailing predominance of dry periods, accompanied with heat waves, erratic rainfall, thunderstorms and floods/erosion, as earlier observed. The results also agreed with Salatalohy et al. [28] who reported that "early planting and harvesting are one of the coping strategies used by the farmers". "Meanwhile, inter-cropping allows cropping systems to reuse their own stored nutrients and with this system productivity per unit area is higher than in mono-cropping systems with the same level of management" [29]. Similarly, about 81.67%, 77.50%, 72.50% and 6.67% of the arable crop farmers identified use of well acclimated crop varieties; changing tillage operations and conserving moisture using mulch respectively. The use of better and well acclimated breed of crop enables farmers to adapt easily to climate change. "High yielding and fast growing crops can easily escape the vagaries of climate change by completing their growth cycle before storm and drought sets-in, thereby checking the impact of climate change" [30]. "Moreover, the use of heat tolerant and drought resistance crops is also effective adaptation practices" [31]. One of the appropriate adaptation strategies by farmers according to Timlin et al. [32] is shading and shelter, which can only be provided through agro-forestry and afforestation. The practice of multiple cropping allows all crop varieties to be sown simultaneously in the same field. "This practice maximises the growth of all crops at the same time in the same field. The farmers incorporate a variety of crops with different growth habits in the same field or home-gardens to maximise the chances for production of multiple crops" [29,32]. Finally, it is evident that the arable crop farmers have various adaptation strategies in adapting to climate change to improve their output, sales, and standard of living in the area.

3.5 Constraints of Arable Crop Farmers in Adaptation to Climate Change

The Table 5 reveals constraints of arable crop farmers in adaptation to climate change in the area. The finding shows that 99.17% of the farmers identified of inadequate information. This could be attributed to dearth in research on climate change as well as poor climate change information dissemination by Nigerian Meteorological Agency (NiMET). This constraint left the farmers unable to get the much needed information on climate change. In the present information age, information problems could pose serious challenges to the farmers' coping strategies as they may not be aware of recent developments regarding climate change adaptations and the necessary readjustments needed. The findings of Esiobu et al. [6,7,22,33] reported that lack of adaptive capacity due to constraints on resources like information may result in further food insecurity. Similarly, about 98.33%, 87.50%, 83.33%, 82.50% and 80.83 of the arable crop farmers identified Inadequate climate change adaptation fund; poor extension contact; high cost of inputs; poor access to farm credit and limited availability of farmland respectively. Inadequate fund left most of the

Table 3. Arable crop farmers perceived effect of climate change on arable crop farming n =120

S/No	Items	SA	A	D	SD	Mean (x̄)	SD (σ)	Decision
1	Resulted to crop planning and management challenges due to unreliable climate data	81 (67.50)	11 (9.17)	16 (13.33)	9 (7.50)	3.31	0.65	High Effect
2	Declining crop yields	16 (13.33)	84 (70.00)	8 (6.67)	12 (10.00)	3.00	0.50	High Effect
3	Increasing water scarcity and drought	20 (16.67)	84 (70.00)	10 (8.33)	6 (5.00)	3.52	0.72	High Effect
4	Increased in new pests and diseases infestation	84 (70.00)	16 (13.33)	10 (8.33)	10 (8.33)	2.88	0.58	High Effect
5	Increased in rate of erosion/flooding	12 (10.00)	80 (66.67)	18 (15.00)	10 (8.33)	2.78	0.55	High Effect
6	Unstable decrease/increase in temperature/rainfall	88 (73.33)	24 (20.00)	4 (3.33)	4 (3.33)	3.63	0.83	High Effect
7	Resulted to changing from farming to non-farming activities	8 (6.67)	84 (70.00)	8 (6.67)	20 (16.67)	2.66	0.64	High Effect
8	Increase in cost of crop seedlings and other inputs	20 (16.67)	78 (65.00)	12 (10.00)	10 (8.33)	2.90	0.60	High Effect
9	Declining of farm sale and income	18 (15.00)	82 (68.33)	14 (11.67)	6 (5.00)	2.93	0.64	High Effect
10	Increasing distance between farms and markets	4 (3.33)	96 (80.00)	7 (5.83)	13 (10.83)	2.80	0.56	High Effect
	Aggregate Mean Score					3.04	0.63	High effect

*Key; SA: Strongly Agreed; A: Agreed; SD: Strongly Disagreed; D: Disagreed; SD (σ); Standard Deviation; Discriminatory index: Cut off point x̄ Key; SA: Strongly Agreed; A: Agreed; SD: Strongly Disagreed; D: Disagreed; SD (σ); Standard Deviation; Discriminatory index: Cut off point x̄≥2.50 Accepted; 0.1-1.99= Low Effect; 2.0-2.49= Moderate Effect; 2.50 and above = High Effect; *Figures in parenthesis are percentage; Field Survey Data, 2024*

Table 4. Arable crop farmers adaptation measures to climate change on arable crop farming

S/No	Adaptation Measures	Frequency	Percentage (%)
1	Diversification of livelihood	119	99.17
2	Changing planting/harvesting dates	117	97.50
3	Agroforestry practices	104	86.67
4	Intercropping of crop	102	85.00
5	Use of well acclimated crop varieties	98	81.67
6	Changing tillage operations	93	77.50
7	Conserving moisture using mulch	87	72.50

**Multiple responses were recorded; Source: Field Survey Data, 2024*

Table 5. Distribution of arable crop farmers based constraints in adaptation to climate change

S/No	Constraints	Frequency	Percentage (%)
1	Inadequate information	119	99.17
2	Inadequate climate change adaptation fund	118	98.33
3	Poor extension contact	105	87.50
4	High cost of inputs	100	83.33
5	Poor access to farm credit	99	82.50
6	Limited availability of farmland	97	80.83
7	High cost of labour	93	77.50
8	Poor breed of crops	90	75.00
9	Poor feeder roads	89	74.17
10	Poor government support for farmers	86	71.67
11	Poor access to market	72	60.00

**Multiple responses were recorded; Source: Field Survey Data, 2024*

farmers unable to get necessary resources in adaptation to climate change in the area. This could be attributed to high cost of adaptation options. Inadequate fund hinders farmers from getting the necessary resources and technologies which assist to adapt successfully to climate change. High cost of labour; poor breed of crops; poor feeder roads; Poor government support for farmers and poor access to market were identified by 77.50%, 75.00%, 74.17%, 71.67% and 60.00% of the arable crop farmers respectively as their constraints to climate change adaptation in the area. Meanwhile, high cost of labour could be attributed to unavailability of family labour. Poor feeder road could result to high cost transportation and poor access to market. This situation left the farmers unable to realize huge profit margin after sales as most of them adopt farm-gate sales. In addition, most of arable crop farmers are also forced to sale below production cost in order not to lose the entire farm produce through post–harvest losses. Finally, there is no doubt that these barriers are responsible for poor adaptation to climate change by the cocoyam farmers in the area. Fighting these problems will be vital in promoting not just local adaptation option but global modern adaptation practices/options to climate change in the area and perhaps beyond.

4. CONCLUSION

Climate change has devastating effects on arable crop growth and yield. Abiotic stresses are the major type of stresses that arable crops suffer [34]. Therefore, adapting to climate change by arable crop farmers is very critical to limit global food insecurity and improve the standard of living for farmers and all. To reduce this effect, farmers must practice several adaptation measures. Understanding arable crop farmers' knowledge of adaptation strategies is among the crucial starting points for deciding what steps should be made to adapt to climate change. The result confirmed the incidence of climate change in the area and farmers perceived rightly the direction of the change, which includes declining crop yields; increased new pests and diseases infestation; heavy decrease and increase in temperature and rainfall among others. Our study further shows that the major climate change adaptation measures farmers practiced were diversification of livelihood and changing planting/harvesting dates. Most of the arable crop farmers were visited at least twice per year by the extension agents in the area. This is quite poor and could negatively affect farmers' adaptation effort to climate change in the area. Extension contact improves farmers' access to recent information, expertise and knowledge on contemporary farming techniques to raise their yield, income and standard of living.

Farmers identified inadequate climate change as among the barriers they faced in adapting to climate change in the area.

5. RECOMMENDATIONS

The following recommendations were made based on the major research observations and findings of the study.

i. The study found the arable crop famers had poor extension contact. Therefore, the agricultural extension system should be strengthened so as to help in transmitting recent climate change innovation to farmers in their farmland for increase yield and income.
ii. The government investment strategies should also focus on expansion of arable crop farmers' farmland and improvement of their education as this would affect their resilience to climate change positively.
iii. Arable crop farmers are therefore encouraged to constantly seek new information on arable crop and its climate change implication before embarking on it production, this will without doubt position them to overcome any adverse effect of poor yield.
iv. The government should assist farmers in implementing climate change policies to reduce the challenges they face and increase arable crop production in the area.
v. Ultimately, since arable crop farmers are members of cooperatives, they are encouraged to take advantage of their strength and shared a common purpose to collectively project a common demand in obtaining funds and other necessary inputs for the implementation and scaling–up of climate change adaptation strategies in the area.

5.1 Areas for Further Study

The constraints of the poor transportation network, insecurity, and limited resources compelled us to select only 120 arable crop farmers across only three (3) out of five (5) states in Southeast Nigeria. Hence, the results are largely applicable to other areas of Nigeria not selected. Additionally, the questionnaire, personal interview method, and focus group discussion of data collection require the respondents to recall from their memories about their socio-economic variables, income, government support, and the perceived effect of climate change on arable crop farming, amongst others. Most arable crop farmers do not keep farm records; hence, the findings may be subject to the memory lapses of the respondents. Therefore, further studies may attempt to link the effect of climate change on arable crop farming with quantitative measurements of farm harvest, farm output per hectare, farm sales, farm income, and other associated production variables. This is to evaluate the actual impact (before, during and after) of arable crop production with a view to checking if farmers' perceptions correspond with the actual quantitative measurement. For instance, farmers may perceive a significant decrease in yield per hectare due to climate change, but the actual measurement may say otherwise, and vice versa. More so, further study (impact) may require monitoring one or more arable crop farming seasons to systematically and logically evaluate. Finally, further research should look at farmers adaptation measures to each arable crop, such as rice, yam, cassava, and maize, rather than aggregating all the arable crops. Farmers' adaptation measures for each arable crop may be different.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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