



# JAMD

Journal of Agricultural  
Management & Development



E-ISSN: 3141-2297  
Volume 1 Issue 1, April, 2026

ISSN 3141-2297



9 773141 229005

Published by:  
**CAERSE | College of Agricultural Economics,  
Rural Sociology & Extension**  
MICHAEL OKPARA UNIVERSITY OF AGRICULTURE, UMUDIKE  
ABIA STATE, NIGERIA

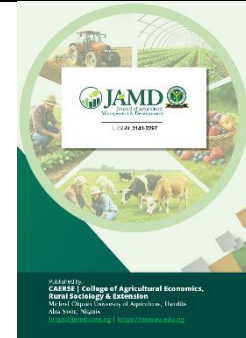
<https://jamd.com.ng> | <https://mouau.edu.ng>



## Journal of Agricultural Management & Development

E-ISSN: 3141-2297

Volume 1 Issue 1, April, 2026



### Analysis of Climate Change Adaptation Strategies Among Smallholder Arable Crop Farmers in Umuahia South L.G.A, Abia State, Nigeria

Nse-Nelson, F. A., Oke, U. R., Onyebinama I.C and Chinagorom, D.U.

#### ARTICLE INFO

**Author(s) Affiliation(s):**

Department of Agricultural Economics,  
Michael Okpara University of Agriculture  
Umudike, Abia State, Nigeria

**Correspondence:**

Email: [floxynse@gmail.com](mailto:floxynse@gmail.com)  
Phone: +2348035236753

**Keywords:**

Climate change, Adaptation strategies, Arable crops, Umuahia South



This is an open access article under the CC BY license

[\(https://creativecommons.org/licenses/by/4.0/\)](https://creativecommons.org/licenses/by/4.0/)

Journal homepage: [www.jamd.com.ng](http://www.jamd.com.ng)

#### ABSTRACT

The study analyzed climate change adaptation strategies among smallholder arable crop farmers in Umuahia South L.G.A, Abia State. Specifically, it examined the socioeconomic characteristics of the farmers, identified their adaptation strategies, assessed their productivity levels, estimated the determinants of productivity, and identified constraints to arable crop production. A multistage sampling procedure was used to select 80 respondents, and data were analyzed using descriptive statistics, Total Factor Productivity (TFP), and multiple regression models. Results showed that respondents had mean age of 46 years, mostly male (60%) and greater percentage of them (57.5%) were married. About 27.50% of them had secondary education with mean household size of 4 persons. The farmers had small farm size ranging from 1–2 ha, and over 10 years of farming experience. Major adaptation strategies included use of improved crop varieties (mean = 3.12), changing planting dates (3.07), and mulching (3.02). About 75% of the farmers had low productivity (TFP between 0.1–0.5), with a mean TFP of 0.48. Productivity was positively influenced by farm size, education, income, experience, and cooperative membership in the multiple regression analysis. Key constraints to arable crop farming included high input cost (mean = 3.78), erratic weather (3.66), pest and disease outbreaks (3.61), and poor access to improved varieties (3.48), with a grand mean of 3.40. Due to high input costs and erratic weather that were observed as critical constraints, it is recommended that investment in climate-resilient practices and input price stabilization be implemented to enhance sustainable arable crop production.

#### Introduction

Arable crop production is the systematic use of land for the purpose of growing of crops that are typically harvested annually (Ajibefun and Oni, 2020). Nigeria has an arable land area of 34 million hectares: 6.5 million hectares for permanent crops, and 28.6 million hectares on meadows and pastures (Food and Agriculture Organization (FAO), 2020). According to the most recent data, some 70 percent of smallholder farmers in Nigeria participate in arable crop farming activities, while about 41 percent own or raise livestock.

Smallholder arable crop farmers are farmers who cultivate crops on small plots of land, usually less than five hectares, and rely on family labor for farming activities (Ajibefun and Oni, 2020). They produce crops like cereals, leguminous plants, potatoes, cotton, beetroot, fodder plants, vegetables, etc. (Kalu and Obioma, 2024). Arable crop production in Nigeria is highly dependent on climate elements such as temperature, rainfall, humidity, and sunshine. These factors significantly influence crop growth, yield, and productivity (Tawakalitu *et al.*, 2022).

However, climate change refers to a long-term alteration in global weather patterns like rises in temperature over time, rainfall fluctuation and storm activity evolved from the potential consequences of the greenhouse effects and continuous deforestation, exerting negative influence on output of arable crop farmers (Osuji *et al.*, 2022). Climate change is majorly characterized by prevalence of severe weather and temperature events, and varying rainfall patterns (Onyeneke *et al.*, 2019).

A changing climate puts arable crop production in danger because arable crops depend on favorable climate conditions to remain productive (Eze *et al.*, 2019). Extreme temperature, carbon dioxide, glacial runoff, precipitation, and their interactions are all abnormal conditions required for optimum arable crop production to occur; extreme climatic conditions distort the carrying capacity of the biosphere to produce arable crop optimally. More so, higher temperatures could lower the yield of desirable arable crops while encouraging weeds and pests' proliferation, and changes in precipitation patterns increase the likelihood of short-run arable crop failure and low productivity in the long run, thus its variability creates a huge challenge for arable crop production (Osuji, Igberi and Ehirim, 2022). However, strategies like intercropping, irrigation, the use of fertilizers, adoption of drought-resistant crop varieties, crop rotation, and improved farming practices can help mitigate the effect of climate change and support optimal arable crop production.

Climate change adaptation strategy encompasses improved arable crop production techniques and management innovation or technologies that are able to balance productivity with low vulnerability to climate change (Mbah, Bassey and Ifenkwe, 2020).

Most farmers in Nigeria and Umuahia, Abia State in particular have successfully created climate change adaption strategies and plans that allow them to continuously deal with and adapt to unpredictable climate change, severe pest attacks, shifting agricultural policies at the local, national, and international levels, as well as other natural factors (Jackson *et al.*, 2021). For example, most farmers adopt mixed systems, using a variety of species, cultivar types, and sowing dates, as well as combining less productive drought-resistant cultivars with high yielding but water-sensitive crops to combat climate change (Eze *et al.*, 2019).

Previous studies on climate change adaptation in Nigeria have largely focused on major crops like cassava and maize but have not sufficiently examined the unique challenges and adaptation strategies employed by smallholder farmers in Umuahia South L.G.A. (Eze *et al.*, 2019). The specific objectives were to examine the socioeconomic characteristics of smallholder arable crop farmers in the study area, identify the climate change adaptation strategies employ by respondents, determine the level of productivity of the farmers, estimate the determinants of the productivity of smallholder arable crop farmers and identify constraints to arable crop production.

### **Methodology**

The study was carried out in Umuahia South Local Government Area (LGA) of Abia State, Nigeria. Umuahia South has an area of 95sq meter (245km<sup>2</sup>), and a population of 320,660 (NPC, 2016). The boundary LGAs are Umuahia North by the north, Isiala-Ngwana north by the south-east, Ikwuano by north-east and Imo River. The people speak Ibeku and Ohuhu as their dialect, and Igbo as a common language. The dwellers are mostly smallholder farmers and civil servants. Umuahia South LGA was created out of the defunct Umuahia L.G.A on the 27 August 1991 and has its headquarters at Apumiri Ubakala, located between latitudes 5°24N and 5°30N of the equator and longitudes 7°32 and 3°37 of the Greenwich Meridian. The LGA is characterized by heavy precipitation of over 200mm per annum as well as minimum and maximum air temperatures of 22°C and 31°C respectively. The mean soil temperature is 28°C, while relative humidity ranges from 69.0% to 79.0%. The major occupation of the people is farming.

The population of the study comprised all arable crop farmers in Umuahia South LGA, Abia State, Nigeria. To select a representative sample, a multistage sampling procedure was used. In the first stage, ten (10)

autonomous communities were purposively selected from the 23 autonomous communities in Umuahia South LGA, based on the availability of arable crop farmers in these communities. In the second stage, one (1) village was randomly selected from these autonomous communities which gave a total of ten (10) villages for the study. In the third stage, eight (8) arable crop farmers were randomly selected from these villages, giving a total of eighty (80) respondents for the study. Primary data were used for this study and were obtained through the use of structured questionnaire administered to respondent through oral interviews. Data were analyzed using both descriptive and inferential statistics such as frequency counts, percentages and means, total factor productivity and multiple regression analysis.

Total Factor Productivity

$$TFP = \sum \frac{P_{yi}Y_i}{P_iX_i+K} \quad (1)$$

Where,

TFP = Total factor productivity

$Y_i$  = quantity of output in kg

$P_{yi}$  = unit price of output in naira

$P_iX_i$  = unit price of input

$X_i$  = input of the  $i$ th farmer

$K$  = fixed cost (depreciation charges, interest on loan)

Between 0.1 and 0.5 is low productivity, 0.6 and 1.0 is moderate productivity and 1.1 and above is high productivity.

To estimate the determinants of the productivity of smallholder arable crop farmers, multiple regression analysis was used and the model is expressed as:

$$Y=f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}) \quad (2)$$

Where  $Y$  = Productivity (as defined in equation 1)

$X_1$  = Age (Years),

$X_2$  = Cost of climate change adaptation strategies (₦),

$X_3$  = Education (Years),

$X_4$  = Income (₦),

$X_5$  = Farm size (ha),

$X_6$  = Household size (Number of persons),

$X_7$  = Amount of credit (₦),

$X_8$  = Farming experience (Years),

$X_9$  = Cooperative membership (1=member, 0 Non-member),

$X_{10}$  = Extension contacts (1=Yes, 0=No)

$e_i$  = error term

## Results and Discussion

Results on the socio-economic characteristics of the arable crop farmers is shown in Table 1. The result showed that the 37.5% of the respondents were between 41 and 50 years, with an average age of 46 years. This implies that arable crop farming in the study area is largely practiced by middle-aged adults. Their active age places them in a position to adopt and experiment with innovations, especially those that mitigate risks associated with climate change. This is in consonance with Ezekiel *et al.*, (2023), who noted that farmers aged between 40 and 55 are more likely to utilize improved agricultural practices compared to older farmers. About 60% of the respondents were male, while 40% were female. This implies that males dominate arable crop farming in the study area. This gender disparity is consistent with the findings of Adeniyi and Yusuf (2023), who reported that arable crop farming in Nigeria is still largely male-dominated, especially in rural areas where mechanization is minimal. A greater proportion (57.5%) of the respondents were married. Marriage plays a crucial role in farming, especially for smallholders, as it often facilitates access to family labour, shared responsibilities, and joint decision-making in farming activities. This is supported by Abdullahi *et al.*, (2024), who noted that marital status significantly influences productivity and resource allocation among rural farmers.

A notable proportion of the farmers had formal education, with 27.5% having SSCE/GCE and 27.5% having FSLC. Only 22.5% had no formal education. The implication is that the majority of the respondents are literate enough to interpret extension advice, keep records, and adopt new technologies. This finding aligns with Agbo *et al.* (2023), who established that higher levels of education positively influence farmers' adoption of climate-smart and productivity-enhancing technologies. Formal education builds analytical thinking and openness to innovation.

Result on household size shows that 87.5% of the respondents had between 1–5 persons in their household, with a mean size of 4 persons. This implies that most farming households are moderately sized and may depend on family labour. Olayemi and Nwankwo (2024) reported that household size affects labour availability, farm size, and income diversification among smallholder farmers. A moderate household size can reduce labour costs and improve timeliness of farm operations.

Furthermore, Table 1 showed that majority (65%) of the respondents operated on farm sizes of less than 1 hectare, indicating small-scale farming. Small farm sizes limit output and often restrict farmers to subsistence production. This also limits access to economies of scale and the potential for mechanization. According to Ajiboye and Abiodun (2023), most Nigerian smallholder farmers cultivate less than 2 hectares, which constrains their access to formal credit and market participation. The small farm size observed may be due to land fragmentation or lack of secure land tenure.

Results show that 56.25% of the respondents had 20–39 years of farming experience, with a mean of 27.6 years. This implies that the majority of respondents are well experienced and have accumulated substantial knowledge about arable crop production. Yahaya *et al.*, (2024) emphasized that experience is a critical asset in dealing with farm-level challenges and exploiting seasonal opportunities. About 48.75% of respondents had contact with extension workers on a fortnightly basis. Regular contact with extension officers is essential for improving farmers' knowledge of new techniques, climate adaptation, pest and disease control, and post-harvest handling. Osuji *et al.*, (2022) reported that frequent extension visits are positively associated with improved crop yield and technology adoption among Nigerian smallholder farmers.

Climate change adaptation strategies used by the farmers is presented in Table 2. Table 2 presents the mean rating of the various climate change adaptation strategies employed by smallholder arable crop farmers in the study area. Results show that the most widely adopted strategy was the use of improved crop varieties (mean = 3.12). These include early-maturing, drought-resistant, and high-yielding varieties that can withstand adverse climatic conditions. Improved seeds are promoted by research institutes and extension agencies to help farmers mitigate losses due to changing rainfall patterns and temperature fluctuations. This aligns with the findings of Yahaya *et al.*, (2024), who noted that the adoption of improved varieties significantly enhances climate resilience and food security in smallholder systems across Nigeria.

The second most adopted strategy was changing planting dates (mean = 3.07). Altering planting calendars helps farmers align their farming practices with unpredictable rainfall onset and duration. It is a low-cost but highly effective response to shifting climatic patterns. Farmers rely on indigenous knowledge, weather trends, or extension advice to make such decisions. Ezekiel and Ogbodo (2023) observed that adjusting planting periods helps smallholder farmers in Sub-Saharan Africa reduce climate-induced crop failure. This suggests that both scientific and local strategies are integrated by farmers to manage climate variability.

In third place was mulching and cover cropping (mean = 3.02), which serves to conserve soil moisture, reduce erosion, and moderate soil temperature. These practices are environmentally friendly and promote sustainable soil health. Additionally, applying organic manure and compost (mean = 2.93) ranked fourth. These options are often more affordable than chemical fertilizers and help maintain soil fertility over time. According to Agbo *et al.*, (2023), organic inputs not only enhance soil productivity but also support microbial activity, which improves long-term soil resilience against climate stressors. Use of irrigation (mean = 2.75) and crop diversification (mean = 2.73) were also highly rated by farmers as important adaptation strategies. Irrigation, though costly and often unavailable in rain-fed farming areas, helps ensure crop survival during dry spells. Diversifying crops spreads the risk of total failure and supports dietary diversity and income security. Olayemi and Nwankwo (2024) emphasized that diversification is a traditional risk management strategy that is increasingly vital under current climate realities.

Level of productivity of the respondents is presented in Table 3. Results in Table 3 showed that a majority (75.00%) of the respondents had Total Factor Productivity (TFP) values between 0.1 and 0.5. This implies that most of the farmers operated below optimal efficiency, producing less output per unit of input. Only 16.25% of the farmers had a TFP between 0.6 and 1.0, indicating moderate productivity, while 8.75% exceeded a TFP of 1.0, signifying relatively efficient use of inputs. The mean TFP of 0.48 confirms that the productivity of the farmers was low. Low productivity among smallholder arable crop farmers may be attributed to limited access to improved technologies, insufficient capital, declining soil fertility, and rising costs of farm inputs. These findings align with those of Oluwatayo and Adedeji (2019), who reported that input underutilization and poor access to credit facilities significantly reduce efficiency among arable farmers in Nigeria.

Determinants of the productivity of smallholder arable crop farmers is presented in Table 4. statistical significance at 0.01, 0.05 and 0.1 probability levels respectively. The regression result of the determinants of productivity of smallholder arable crop farmer is shown in Table 4. The linear functional form was chosen as the lead equation. This was based on statistical and econometric reasons which include the magnitude of the coefficient of multiple determination, the number of significant variables, as well as the significance of F-ratio. The coefficient of multiple determination ( $R^2$ ) was 0.64 which implies that 64.00% of the variations in productivity of the respondents was explained by the independent variables included in the model while 36.00% unexplained was due to error factor. The F-ratio of 13. was statistically significant at 1% significant level indicating that the variables included in the estimated regression model were correct and has a line of best fit.

Cost of adaptation was statistically significant at 1% level and negatively influenced productivity. This implies that higher costs incurred in adapting to climate change tend to reduce the productivity of smallholder farmers. When adaptation strategies are expensive, farmers either adopt them partially or not at all, which results in suboptimal yield. This finding is supported by Arslan *et al.*, (2022), who found that high costs discourage adoption of climate-resilient technologies among smallholders in sub-Saharan Africa. In Nigeria, studies such as Enete *et al.*, (2023) reported that rising costs of adaptation inputs like fertilizers, drought-resistant seeds, and irrigation equipment significantly reduce output levels for arable crop farmers. Level of education had a positive and significant effect on productivity at 10%. This implies that educated farmers are more likely to adopt best agronomic practices, interpret extension messages correctly, and utilize available resources efficiently. Education enhances decision-making capacity, which is crucial for input use, time management, and embracing innovation. Further supporting this, Ojo *et al.*, (2024) in their study on cassava farmers in southern Nigeria noted that basic literacy helps farmers access agro-information via mobile platforms, better understand market signals, and engage more proactively in cooperative societies.

Income was statistically significant and positively related with productivity at 10%. This implies that higher income levels increase farmers' ability to procure quality inputs such as improved seeds, fertilizers, and agrochemicals, as well as invest in better land management and labour. With more income, farmers are also better positioned to take risks, innovate, and scale production. Iheanacho *et al.*, (2023) emphasized that income-generating opportunities enable farmers to mitigate shocks such as crop failure or market volatility, thereby stabilizing production across seasons.

Farm size had a significant and positive relationship with productivity at 1%. This implies that as farm size increases, so does output per farmer. Larger farm sizes allow for crop diversification, better land rotation practices, and the possibility of employing mechanized farming. According to Barrett *et al.*, (2021), farm size remains a critical determinant of agricultural performance across developing economies, with productivity gains often accruing from economies of scale. Akwa Ibom and Cross River States, arable crop farmers with larger landholdings tended to allocate more resources per hectare and generated higher returns than those with smaller plots.

Farming experience had a positive and highly significant effect on productivity at 1%. This implies that experienced farmers possess accumulated knowledge about local soil conditions, rainfall patterns, pest and disease cycles, and best planting periods. Such experiential knowledge helps in minimizing losses and optimizing output. This is corroborated by Adeola and Akinbode (2022), who found that farmers with more years of experience achieved better efficiency scores in rice production in Ogun State.

Cooperative membership was significant and had a positive relationship with the productivity of the farmers at 5%. Membership in farmer groups facilitates access to shared resources, group marketing, financial services, and bulk input purchase at reduced costs. Cooperatives serve as platforms for knowledge exchange and capacity building, increasing overall productivity. Agbo *et al.*, (2023) reported that cooperative-affiliated yam farmers in Benue State recorded 18% higher yields than non-members due to joint input procurement and extension services.

Results in Table 5 showed a grand mean of 3.40, indicating that the constraints listed broadly hinder productivity. High cost of farm inputs ranked highest ( $\bar{X} = 3.78$ ), implying that inputs like fertilizer, improved seeds, and agrochemicals are becoming unaffordable. This aligns with Abdullahi *et al.*, (2024), who observed that rising inflation and removal of input subsidies in Nigeria have made it difficult for smallholders to access critical inputs. Unpredictable weather conditions ( $\bar{X} = 3.66$ ) and pest/disease outbreaks ( $\bar{X} = 3.61$ ) were also major constraints. These findings corroborate studies by Ayanlade and Radeny (2020) who reported that climate variability, including erratic rainfall and temperature extremes, frequently disrupts planting cycles and exposes crops to pest invasions. Similarly, poor access to improved crop varieties ( $\bar{X} = 3.48$ ) and limited extension services ( $\bar{X} = 3.42$ ) further reduced the capacity of farmers to adopt better-yielding technologies and management practices, a concern also emphasized by Ezekiel *et al.*, (2023). Inadequate access to credit ( $\bar{X} = 3.36$ ) continues to restrict farmers' ability to scale operations or invest in productivity-enhancing inputs. This is consistent with Oluwatayo and Adedeji (2019), who noted that only a small fraction of rural farmers in Nigeria has formal credit access due to collateral and interest rate challenges. Lack of irrigation ( $\bar{X} = 3.30$ ) further aggravates production risks, particularly in dry spells, while decline in soil fertility ( $\bar{X} = 3.21$ ) reflects years of continuous cultivation and poor soil management practices. Also noteworthy are land disputes/limited land access ( $\bar{X} = 3.15$ ) and poor road infrastructure ( $\bar{X} = 3.02$ ), which limit both production and market access. Abdullahi *et al.*, (2024) reported that unresolved land tenure issues and rural infrastructure decay significantly reduce the efficiency and motivation of smallholder farmers.

### Conclusion and Recommendations

Most smallholder arable crop farmers were male, married, experienced, and operated on small farms. The productivity of most of the farmers was low. Cost of adaptation strategies, farm size, education, income, experience, and cooperative membership influenced the productivity of the farmers. Major constraints identified were high input costs, unpredictable weather, pest/disease outbreaks, and poor access to improved crop varieties. Since high input cost and erratic weather were major constraints, investment in climate-resilient farming practices and price stabilization mechanisms is essential to support sustainable arable crop production.

### References

- Abdullahi, T. Y, Abdulazeez, A., Ahmed, M. M., Usman, U. N., Uba, A., Shehu, S., and Ndakuru, M. A. (2024). Assessment of coping and adaptation strategies to climate change by arable farmers in Northwestern Nigeria. *FUDMA Journal of Earth and Environmental Sciences*, 1(02), 1–12.
- Adeniyi, T. and Yusuf, B. (2023). Gender roles in arable crop production in Nigeria: Emerging challenges and policy needs. *Journal of Agricultural Policy*, 15(2), 101–113.
- Adeola, R. G., and Akinbode, S. O. (2022). Farming experience and efficiency of rice farmers in Ogun State. *Journal of Agricultural Economics and Development*, 11(2), 122–130.
- Agbo, C. O., Okonkwo, J. C., and Emeka, L. A. (2023). Organic-based strategies for enhancing resilience to climate change in Nigerian farms. *African Journal of Soil and Climate*, 11(2), 57–69.
- Ajibefun, I. A and Oni, O. A. (2020). Smallholder agriculture and food security in Nigeria: Challenges and prospects. *Journal of Agricultural Economics and Development*, 9(2), 45-56.
- Ajiboye, A. T., and Abiodun, O. A. (2023). Landholding and productivity in Nigerian smallholder agriculture. *Journal of Sustainable Agriculture*, 12(4), 234–248.
- Arslan, A., McCarthy, N., and Lipper, L. (2022). Cost constraints and adoption of climate-smart practices. *Agricultural Systems*, 197, 103-112.
- Ayanlade, A and Radeny, M. (2020). Variability in climate change adaptation strategies among smallholder farmers in sub-Saharan Africa. *Environmental Development*, 33, 100504.
- Barrett, C. B., Carter, M. R., & Timmer, C. P. (2021). A Century-Long Perspective on Agricultural Productivity and Poverty Reduction. *Journal of Development Studies*, 57(12), 1860–1877.
- Enete, A. A., Okoro, J. I., and Nwosu, C. S. (2023). Adaptation costs and productivity in Nigeria. *International Journal of Agricultural Management*, 9(1), 26–35.

- Eze, C. N., Okpala, I. N and Nwosu, P. O. (2019). Farmers' adaptation strategies to climate change in Nigeria. *African Journal of Agricultural Research*, 14(5), 230-241.
- Ezekiel, U. I., and Ogbodo, C. N. (2023). Rainfall shifts and seasonal farming in Nigeria: A study of adaptive practices. *African Journal of Agricultural Extension*, 16(3), 112–126
- Ezekiel, U. I., Eze, C. C., and Obasi, P. C. (2023). Demographic determinants of productivity among smallholder farmers in Nigeria. *Journal of Agricultural Economics and Development*, 11(3), 78–89.
- Food and Agriculture Organization (FAO). (2020). Nigeria: Country fact sheet on food and agriculture policy trends. FAO. Retrieved from <https://www.fao.org>
- Iheanacho, A. C., Ugwumba, C. O. A., and Olowolafe, E. A. (2023). Farm income and smallholder productivity in northern Nigeria. *Nigerian Agricultural Journal*, 54(3), 98–107.
- Kalu, A. B and Obioma, O. (2024). Arable Crop Production in Nigeria: A Comprehensive Review. *Journal of Agricultural Development*, 12(1), 23-45.
- Mbah, E. N., Bassey, N. O and Ifenkwé, G. E. (2020). Climate change adaptation strategies among rural farmers in Nigeria. *Journal of Environmental Management*, 35(4), 293-310.
- National Population Commission (NPC). (2016). Population distribution by sex, state, LGA, and senatorial district: census priority tables (Vol. 3). NPC.
- Ojo, M. A., Yusuf, S. A., and Adegbite, D. A. (2024). Determinants of cassava output among smallholder farmers in southern Nigeria. *Journal of Development and Agricultural Economics*, 16(2), 45–53.
- Olayemi, T. O., and Nwankwo, J. U. (2024). Risk-spreading and diversification as climate adaptation tools among Nigerian smallholders. *Development in Practice*, 34(2), 185–202
- Oluwatayo, I. B., and Adedeji, T. A. (2019). Efficiency and productivity differentials among arable crop farmers in Southwestern Nigeria. *Journal of Agricultural Economics and Development*, 8(2), 23–33.
- Onyeneke, R. U., Chidiebere, O. M and Ehirim, N. C. (2019). Impact of climate change on crop production in Nigeria: Evidence from panel data analysis. *Climate Change Economics*, 10(4), 1950012. <https://doi.org/10.xxxx/CCE.2019.1004>
- Osuji, E. C., Igberí, C. O and Ehirim, K. C. (2022). Effects of climate variability on smallholder farmers in Nigeria. *Journal of Agricultural Research and Development*, 14(1), 51-67.
- Tawakalitu, S. A., Yusuf, M. A and Ibrahim, T. A. (2022). Climate change and agricultural sustainability in Nigeria. *African Journal of Environmental Science*, 9(3), 201-215.
- Udoh, E. J., and Eyo, E. O. (2024). Farm size and productivity in the Niger Delta Region of Nigeria. *Nigerian Journal of Agricultural and Resource Economics*, 15(1), 78–91.
- Yahaya, M. A., Musa, A. and Bello, R. I. (2024). Farming experience and resilience to climate shocks among arable farmers in Northern Nigeria. *Agricultural Systems and Resilience*, 5(1), 90–105.

## Appendix

**Table 1: Socio-economic Characteristics of the Smallholder Arable Crop Farmers**

Variable	Frequency (n=80)	Percentage (%)
<b>Age (years)</b>		
20 – 30	6	7.50
31 – 40	16	20.00
41 – 50	30	37.50
51 – 60	25	31.25
61 – 70	3	3.75
<b>Mean</b>	<b>46</b>	
<b>Sex</b>		
Male	48	60.00
Female	32	40.00
<b>Marital Status</b>		
Married	46	57.50
Single	34	42.50
<b>Level of Education</b>		
No formal education	18	22.50
Primary	22	27.50
Secondary	21	26.25
Tertiary	19	23.75
<b>Household Size</b>		
1 – 5	70	87.50
6 – 10	10	12.50
<b>Mean</b>	<b>4</b>	

Variable	Frequency (n=80)	Percentage (%)
<b>Farm Size</b>		
0.1 – 0.9	52	65.00
1.0 – 1.9	26	32.50
2.0 – 2.9	2	2.50
<b>Mean</b>	<b>0.9</b>	
<b>Farming Experience</b>		
1 – 19	15	18.75
20 – 39	45	56.25
40 – 49	20	25.00
<b>Mean</b>	<b>27.6</b>	
<b>Extension Contacts</b>		
Not at all	34	42.50
Fortnightly	39	48.75
Quarterly	4	5.00
Annually	3	3.75

Field Survey, 2025

**Table 2: The mean rating of climate change adaptation strategies employed by respondents (n=80)**

Adaptation strategies	Cum	Mean	Rank
Use of improved crop varieties (UICV)	374	3.12	1 <sup>st</sup>
Changing planting dates (CPD)	368	3.07	2 <sup>nd</sup>
Mulching and cover cropping (MCC)	362	3.02	3 <sup>rd</sup>
Application of organic manure and compost (AOMC)	351	2.93	4 <sup>th</sup>
Use of irrigation (IRR)	330	2.75	5 <sup>th</sup>
Crop diversification (CD)	328	2.73	6 <sup>th</sup>
Avoidance of flood-prone areas (AFPA)	322	2.68	7 <sup>th</sup>
Tree planting/agroforestry (TPA)	290	2.42	8 <sup>th</sup>

Source: Field survey, 2025: Critical mean score = 2.50. Decision rule: Mean  $\geq$  2.50 = Accepted while Mean  $<$  2.50 = Rejected

**Table 3: Distribution of respondents according to level of productivity**

Total Factor Productivity	Frequency	%
0.1 – 0.5	60	75.00
0.6 – 1.0	13	16.25
1.1 – 1.5	3	3.75
1.6 – 2.0	4	5.00
<b>Total</b>	<b>80</b>	<b>100</b>
<b>Mean</b>	<b>0.48</b>	

Source: Field Survey, 2025

**Table 4: Determinants of the productivity of smallholder arable crop farmers**

Variables	(+) Linear	Exponential	Semi log	Double log
Intercept	1.71 (6.89) ***	0.58 (6.23) ***	0.40 (2.23) **	0.89 (3.61) ***
Age	-1.02 (-1.48)	-0.04 (-1.39)	-0.09 (-1.31)	-0.58 (-1.42)
Cost of adaptation	-0.26 (2.02) ***	-0.05 (-2.12) **	-0.024 (-2.01) **	-0.14 (-2.32) **
Level of education	0.01 (1.81) *	0.04 (1.65) *	0.06 (1.47)	0.31 (1.78)
Income	0.09 (1.90) *	0.03 (1.94) *	0.09 (1.89) *	0.08 (1.81) *
Farm size	0.42 (3.21) ***	0.39 (3.34) ***	0.22 (2.77) ***	0.38 (3.46)
Household size	0.03 (1.21)	0.17 (1.2)	0.05 (1.10)	0.02 (1.35)
Access to credit	0.09 (1.21)	0.08 (1.17)	0.02 (1.09)	0.01 (1.38)
Experience	0.11 (2.88) ***	0.09 (2.61) ***	0.09 (2.61) ***	0.19 (3.01) ***
Cooperative membership	0.38 (2.45) **	0.29 (2.03) **	0.16 (1.80) *	0.24 (2.11) **
Extension contacts	0.12 (1.39)	0.09 (1.40)	0.05 (1.32)	0.10 (1.44)
<b>R<sup>2</sup></b>	<b>0.64</b>	<b>0.61</b>	<b>0.58</b>	<b>0.63</b>
<b>R<sup>-2</sup></b>	<b>0.59</b>	<b>0.56</b>	<b>0.52</b>	<b>0.58</b>
<b>F-ratio</b>	<b>13.29***</b>	<b>11.74</b>	<b>10.32***</b>	<b>12.86***</b>

Source: Field Survey, 2025: Note: values in parentheses () are the respective t- ratio. \*\*\*, \*\*, and \* implies

**Table 5: Mean rating of the respondents on the constraints to arable crop production among smallholder farmers**

Constraints	$\bar{X}$	Decision
High cost of farm inputs (e.g., seeds, fertilizer, chemicals)	3.78	Accepted
Unpredictable weather conditions affecting planting and harvesting	3.66	Accepted
Pest and disease outbreaks	3.61	Accepted
Poor access to improved crop varieties	3.48	Accepted
Limited access to extension services	3.42	Accepted
Inadequate access to credit facilities	3.36	Accepted
Lack of irrigation or water management systems	3.30	Accepted
Decline in soil fertility due to overuse or environmental degradation	3.21	Accepted
Land disputes or limited access to farmland	3.15	Accepted
Poor transportation and road infrastructure	3.02	Accepted
<b>Grand Mean</b>	<b>3.40</b>	<b>Accepted</b>

Source: Field survey, 2025: Decision rule: Mean  $\geq$  2.50 = Accepted while Mean  $<$  2.50 = Rejected.