



Adoption of climate change adaptation strategies and yield of maize in Ogun state, Nigeria: Does microcredit access matter?

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Abstract

The study focused on assessing the influence of microcredit access on the adoption of climate change adaptation strategies and maize yield in Ogun State, Nigeria. It employed a sample of 120 farmers selected through a multistage sampling technique, and data were gathered via well-structured questionnaires. Descriptive statistics, binary logistic regression model, and multiple regression analysis were utilized for data analysis. The study found that a majority (53.3%) of respondents were male, with a mean age of 49 years. The main adaptation strategies adopted by maize farmers in response to climate change variations included engagement in non-farm activities (72.5%), use of fertilizer/manure (70.8%), high-quality-improved seeds (59.2%), shifting cultivation (57.5%), and irrigation (56.7%). Results from the binary logistic regression model revealed a direct significant relationship between microcredit access and adoption of climate change adaptation strategies. Additionally, the multiple regression analysis revealed that access to microcredit, along with other socio-economic factors like sex, household size, farm size, experience, and membership of farmers' association, had a significantly positive effect on maize yield. The study concluded that microcredit played a vital role in helping farmers adapt to climate change and boost maize productivity in the study area. Consequently, implementing accessible and affordable microcredit schemes could be a strategic move for policymakers and stakeholders to prioritize in supporting farmers and fostering resilience in the face of climate challenges. This approach could potentially enhance farmers' resilience to climate change and contribute to improved agricultural productivity in the region.

Keywords: Adaptation strategies, Adoption, Climate change, Maize, Microcredit, Yield.

Citation | Oluremi, A. F., Farouq, M. A., & Abd'Malik, S. (2026). Adoption of climate change adaptation strategies and yield of maize in Ogun state, Nigeria: Does microcredit access matter? *Agriculture and Food Sciences Research*, 13(1), 31–37. 10.20448/aesr.v13i1.8472

History:

Received: 27 January 2026

Revised: 25 March 2026

Accepted: 31 March 2026

Published: 15 April 2026

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Publisher: Asian Online Journal Publishing Group

Funding: The study was self-sponsored.

Institutional Review Board Statement: The study involved minimal risk and followed ethical guidelines for social science fieldwork. Formal approval from an Institutional Review Board was not required under the policies of Yaba College of Technology, Lagos State, Nigeria. Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.

Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Competing Interests: The authors declare that they have no competing interests.

Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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Contribution of this paper to the literature

The study is original in jointly analyzing level of climate change adaptation strategies and maize yield outcomes while estimating the role of microcredit access using binary logistic and multiple regression models. It provides micro-level evidence from Ogun State, where limited studies link climate finance, adaptation behavior and crop productivity.

1. Introduction

Maize (*Zea mays* L.) is an annual cereal crop belonging to the family Poaceae, cultivated and consumed worldwide. It serves as a staple food for billions globally, particularly in Africa, Latin America, and Asia, contributing significantly to global calorie intake [1, 2]. In Nigeria, maize holds particular importance as the country's primary staple food, with the southwest region dedicating a substantial portion of cropland to its cultivation, making it a significant local cash crop [3]. Over time, maize production in Nigeria has increased, with the country reaching a production volume of 12.4 million metric tons in 2020 and 12.75 million metric tons in 2021. In the marketing year 2022/2023, Nigeria's estimated maize production was 12.7 million metric tons, with an average yield of 2.2 tons per hectare [4, 5].

Maize is predominantly grown by small-scale farmers, often at subsistence levels, either as a sole crop or intercropped with other cereals. The production of maize by these farmers is characterized by small land holdings, rudimentary production methods, low productivity, and limited resources, resulting in low output [6]. Maize, along with other cereals, is an essential source of carbohydrates, proteins, vitamin B, and minerals, contributing significantly to human nutrition [7]. Maize's versatility extends beyond its role as a food staple; it is extensively utilized in various industries [8]. It serves as a primary ingredient in animal feed for poultry, a crucial component in the production of beer and malt drinks, a source of ethanol for biofuel, and a raw material for starch and syrup used in medical applications [9]. Due to its nutritional value and the wide range of products and by-products derived from it, maize is often referred to as the "cereal of the future." Its diverse uses underscore its importance in both food security and industrial applications, making it a crucial crop in agricultural systems worldwide [10, 11].

Crop production in Nigeria faces numerous challenges, including technological, institutional, and climatic factors [12]. Climate variability significantly impacts crops like maize, leading to increased disease and pest infestations, erratic rainfall patterns, higher temperatures, intensified sunlight, flooding, erosion, prolonged droughts, loss of biodiversity, soil moisture, and reduced income [13]. These challenges are expected to worsen as global climate change progresses. Given the potential for climate change to further disrupt productivity, farmers must adopt adaptation strategies to mitigate its effects [14]. Adaptation involves adjusting agricultural practices to accommodate or respond to changes in climate variables [15]. Failure to adapt adequately can result in reduced productivity and financial losses for farmers, especially when faced with unpredictable weather conditions. Therefore, it's crucial to empower smallholder farmers to build adaptive capacities for changing weather conditions. Access to microcredit is one way to support farmers in this regard, as it provides them with financial resources to implement adaptation measures and invest in resilient farming practices [14].

Microcredit refers to easily repayable small loans that low-income individuals, including smallholder farmers, obtain informally from friends, relatives, people within their networks, or formal credit lending institutions such as banks and microfinance institutions [16]. These small loans are aimed at supporting individuals in engaging in productive activities, including agricultural production [17]. Access to microcredit enhances farmers' purchasing power, enabling them to acquire necessary inputs for investment in production activities [18]. It plays a significant role in boosting farmers' ability to adopt technologies that were previously considered capital-intensive, particularly in adapting to climate change [19]. However, farmers often face challenges in accessing credit due to bureaucratic processes, difficult application procedures, and restrictions imposed by official lending institutions [20]. Recent studies, Bakare, et al. [14] have identified various factors that determine farmers' access to credit, including age, educational level, farming experience, income level, proximity to credit sources, asset ownership, repayment flexibility, household labor, credit information, farm size, and awareness of adaptation strategies. Therefore, this study aims to investigate the effect of microcredit access on the adoption of climate change adaptation strategies and maize yield in the study area. It contributes valuable insights to the intersection of climate change and microfinance literature by identifying the sources and uses of microcredit by farmers, exploring the adaptation strategies adopted by maize farmers, discussing factors influencing farmers' access to microcredit, and assessing the impact of microcredit access on maize yield.

2. Methodology

The study was conducted in Ogun State, Nigeria, which is located in the south-western part of the country. Established on February 3, 1976, from the former Western State, Ogun State is situated at coordinates 7°N 3.5°E on the equator, with its capital city being Abeokuta. Ogun State shares borders with Lagos State to the south, Oyo and Osun States to the north, Ondo State to the east, and the Republic of Benin to the west. The state comprises twenty Local Government Areas and covers a land area of 16,667 square kilometers, with a total population of approximately 6,379,500 residents according to the Ogun State Central Department of Statistics [21]. Farming is the primary occupation of the people in Ogun State, with the state being renowned as the highest producer of kolanut. Additionally, the state cultivates other crops such as cassava, maize, yams, plantain, rubber, and cocoa. Livestock farming, including poultry, cattle, sheep, goats, and pigs, is also prevalent for both sales and consumption purposes in the state.

The study utilized a multistage sampling procedure. First, two Local Government Areas (LGAs), Yewa North and Yewa South, were purposively selected due to the high concentration of maize farmers in these areas. Then, using a random sampling method, two communities were chosen from each selected LGA, resulting in a total of four communities. The list of communities served as the sampling frame for this stage. Finally, in the third stage, a simple random sampling technique was used to select 30 maize farmers from each of the four communities, resulting in 120 maize farmers for the study. Data collection was conducted using a combination of oral and

written interviews with the aid of well-structured questionnaires, allowing for the collection of primary data directly from the selected farmers.

2.1. Analytical Techniques

Descriptive statistics were used to summarize respondents' socio-economic attributes, highlight sources and utilization of credit, and identify adaptation strategies adopted to mitigate climate change effects on maize production.

The binary logistic regression model was employed to investigate the effects of microcredit on the adoption of climate change adaptation strategies by maize farmers. The model is specified as:

$$Y = \alpha + \beta X + ei \tag{1}$$

Where, Y = adoption of adaptation strategies (1 if adopted, 0 otherwise); X = Access to microcredit (dummy), α = Constant/intercept, β = Coefficient, ei = Stochastic error term

Multiple regression analysis was used to examine the effects of microcredit and other socio-economic variables on maize yield in the study area. The model is specified as:

$$Z = \beta_0 + \beta_1V1 + \beta_2V2 + \dots + \beta_{10}V10 \tag{2}$$

β_0 = Constant; $\beta_1 \dots \beta_{10}$ = Coefficients of the explanatory variable V1.....V10 (Socio- economic variables which are: Z = Income (₦); V1 = Amount of microcredit received by the maize farmers (₦), V2 = Age (Years), V3 = Sex of farmer (1 = Male; 0 = Otherwise), V4 = Education (Years), V5 = Household Size (Number of persons), V6 = Farm Size (Ha), V7 = Farming Experience (Years), V8 = Membership of association (Dummy), V9 = Extension contact (Dummy)

3. Results and Discussion

3.1. Socio-Economic Characteristics of the Maize Farmers

Table 1 presents a summary of selected socio-economic characteristics of maize farmers. The results show that the majority (53.3%) of respondents were male. A significant proportion (41.7%) fell within the 41-50 years age range, with an average age of about 43 years. Most (38.3%) had secondary education. The mean household size, farming experience, and farm size were approximately 6 persons, 15 years, and 1.1 hectares, respectively. Few (32%) of the respondents had contact with extension agents, and 23.2% were members of farmers' associations. Regarding access to microcredit, the distribution revealed that the majority (52.5%) of farmers had access, while 47.5% did not. Among those with access, a larger proportion (27.5%) received loans ranging from ₦101,000 to ₦300,000.

Table 1. Selected Socio-economic characteristics of the maize farmers.

Variables	Frequency	Percentage	Mean
Sex			
Male	64	53.3	
Age			
41-50	50	41.7	49.33±10.475
Educational Qualification			
Secondary education	46	38.3	
Household Size			
6-10	66	55.0	6.39±2.491
Farming Experience			
≤10	59	49.2	15.02±10.639
Farm Size			
≤1	93	77.5	1.1436±0.9480
Extension Contact			
Yes	39	32.5	
Farmers Association			
Yes	28	23.2	
Microcredit Access			
Yes	63	52.5	
Volume of Loan Received			
101,000-300,000	33	27.5	153,916.67 ±10907.391

Note: n = 120.

3.2. Sources of Microcredit used by the Respondents in the Study Area

Figure 1 illustrates the sources of microcredit available to respondents. The results indicate that 47.5% of respondents had access to microcredit in the previous season. The sources from which farmers obtained microcredit include microfinance banks, cooperative societies, family and friends, commercial banks, and money lenders. Specifically, 2.5% of maize farmers obtained microcredit from money lenders, while 11.7% received it from commercial banks. Additionally, 16.7% of farmers acquired microcredit from family and friends, 20.8% from cooperative societies, and 22.5% from microfinance banks. This result supports [22] who reported that access to microcredit plays a critical role in influencing climate change adaptation decisions by farmers among rice farmers in southwestern Nigeria.

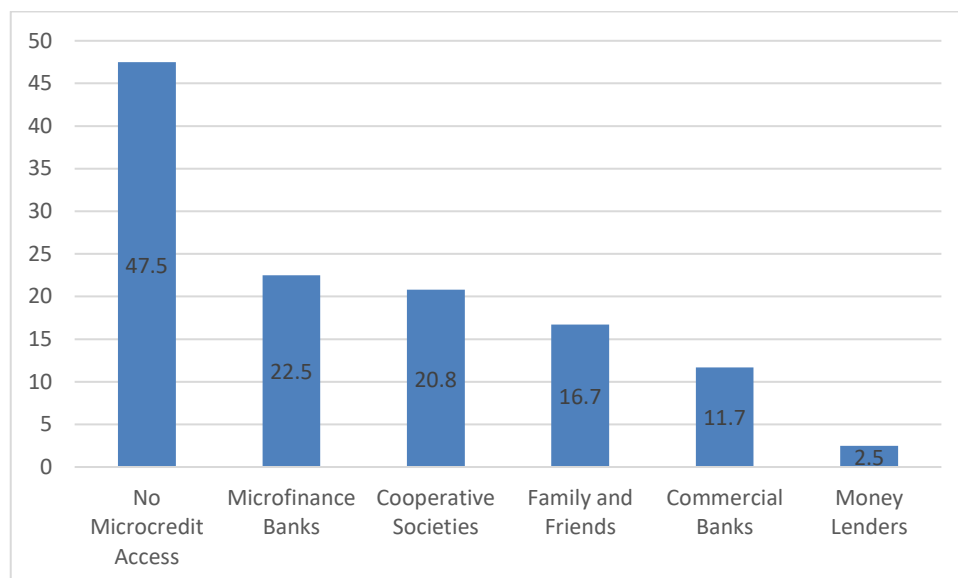


Figure 1. Sources of microcredit in the study area.

3.3. Distribution of Respondents Based on Maize Farmers’ Utilization of Microcredit

Table 2 presents the findings on maize farmers’ utilization of microcredit. Farmers use microcredit primarily to purchase inputs such as maize seeds, fertilizer, and farm tools to enhance yield and undertake land preparation. According to the study’s results, approximately 28.3% of maize farmers used the obtained loan to purchase high-quality, improved seeds, while 27.5% utilized it for drilling boreholes or irrigation facilities. Moreover, 17.5% of farmers used microcredit to purchase fertilizer, 15.8% for paying children’s school fees, and 12.5% diversified the loan into non-farm activities. Additionally, 9.2% of farmers allocated the microcredit for the construction of trenches and barricades, 8.3% for employing more labor for land preparation and weeding, and 6.7% each for purchasing chemicals for crop spraying and acquiring farm equipment. Furthermore, 4.2% used microcredit to purchase land for farming, 2.4% for completing private building projects, and 1.7% diversified it into other farming activities. The diverse utilization of microcredit by maize farmers underscores its significance in facilitating various agricultural activities and investments to improve productivity and livelihoods.

Table 2. Use of microcredit by the respondents in the study area.

Uses	Frequency	Percentage	Rank
Purchase land for farming	5	4.2	9 th
Purchase improved seeds	34	28.3	1 st
Purchase fertilizers	21	17.5	3 rd
Purchase chemicals for spraying crops	8	6.7	8 th
Employ more labour for land preparation and weeding	10	8.3	7 th
Purchase farm equipment such as cutlasses, hoes, sprayers, and so on	8	6.7	8 th
Drill a borehole or irrigation facilities	33	27.5	2 nd
Construction of trenches and barricades for soil erosion	11	9.2	6 th
Diversification into other farming activities	2	1.7	11 th
Diversification into non-farm activities	15	12.5	5 th
Pay children's school fees	19	15.8	4 th
Complete private building project	3	2.4	10 th

3.4. Adaptation Strategies Adopted by Maize Farmers in the Study Area

Table 3 presents ten emerging and indigenous methods used for climate change adaptation in the study area. These adaptation strategies aim to increase the capacity of farming systems to survive external shocks or changes in climate conditions. Adaptive capacity is essential for farmers to adjust to climate change, including variability and extremes, moderate potential damages, seize opportunities, and cope with consequences effectively [23]. These strategies include the use of improved seeds, mono-cropping, shifting cultivation, the use of irrigation, and conservation of soil moisture through mulching. Others include adjustment in planting and harvesting times, diversification into other farming activities, engagement in non-farm activities, use of fertilizer/manure, as well as pesticides.

Table 3. Adaptation Strategies adopted by the maize farmers in the study area.

Strategies	Frequency	Percentage	Rank
Use of improved seeds	71	59.2	3 rd
Mono-cropping	12	10.0	10 th
Shifting cultivation	69	57.5	4 th
Use of irrigation	68	56.7	5 th
Conserve soil moisture through mulching	40	33.3	7 th
Adjustment in planting and harvesting time	62	51.7	6 th
Diversification into other farming activities	15	12.5	9 th
Engagement in non-farm activities	87	72.5	1 st
Use of fertilizer/manure	85	70.8	2 nd
Use of pesticides	38	31.7	8 th

The study findings indicate that livelihood diversification is the primary adaptation strategy adopted by maize farmers in the study area, with engagement in non-farm activities (72.5%) being the most favored strategy among respondents. This highlights the recognition among farmers of the instability of farm incomes in the study area and the need for alternative livelihood sources to sustain their families amidst climate change challenges. Despite having knowledge about the benefits of using animal manure as organic fertilizer to improve maize yield, only 70.8% of maize farmers applied it on their farms as an adaptation strategy to cope with soil fertility reduction. This highlights a gap between knowledge and practice among farmers, indicating potential areas for intervention or education to encourage more widespread adoption of sustainable agricultural practices. Notably, 59.2% of farmers used improved maize seeds, particularly drought-tolerant and short-maturing varieties, to reduce the adverse effects of climate change. This result resonates with the findings by Ajibade, et al. [24] that smallholder rice farmers are more attuned to changing the variety of rice they plant as a strategy to mitigate flood-related losses.

Additionally, 57.5% adopted shifting cultivation, while 56.7% engaged in irrigation farming, despite its capital-intensive nature. Furthermore, 51.7% of farmers varied their planting and harvesting calendars based on rainfall patterns, reflecting the heavy reliance on weather and climate characteristics in agricultural planning. About 33.3% practiced soil moisture conservation through mulching, while 31.7% used intensive pesticides to control pests and diseases. Crop diversification was employed by 12.5% of maize farmers to enhance resilience in the agricultural sector. It is noteworthy that adaptation strategies varied in their adoption rates, reflecting the diverse needs and preferences of farmers in the study area. While livelihood diversification and the use of improved maize seeds were widely embraced, mono-cropping was less favored, with only 10% of farmers adopting this strategy.

3.5. Effect of Access to Microcredit on Adoption of Climate Change Adaptation Strategies

The binary logistic regression model results demonstrate a significant positive effect of access to microcredit on the adoption of climate change adaptation strategies by maize farmers in the study area (Table 4). The Nagelkerke R² value of 0.419 indicates that approximately 42% of the factors influencing the adoption of climate change adaptation strategies were explained by microcredit access. Additionally, the likelihood ratio statistic showed a highly significant p-value of 0.000, indicating that the model fits the data well.

Table 4. Effects of access to microcredit on adoption of climate change adaptation strategy.

Variable	Coefficient	Std. error	Z	Sig.
Constant	0.577	0.462	21.238	0.072
Access to microcredit	1.674***	0.363	5.333	0.001
-2 Log likelihood	90.309			0.000
Cox & Snell R Square	0.311			
Nagelkerke R Square	0.419			

Note: *** indicate significance at 1%, respectively.

The coefficient of access to microcredit was found to be positive and statistically significant ($p < 0.01$), indicating that increased access to microcredit is associated with a higher likelihood of maize farmers adopting climate change adaptation strategies. This suggests that microcredit plays a crucial role in enabling farmers to invest in technologies and resources necessary for adapting to climate change challenges. These findings are consistent with previous research, which has highlighted the importance of credit access as a major determinant of farmers' adaptation strategies. Studies by Mmbando, et al. [25] and Bakare, et al. [14] have all reported similar results, emphasizing the positive impact of microcredit on farmers' adaptation behaviour.

3.6. Effect of Access to Microcredit and Other Socio-economic Variables on the Yield of Maize

The result of the multiple regression model is presented in Table 5. The choice of the semi-log model as the primary equation was appropriate, considering its higher coefficient of determination (R²), F-value, and significant variables compared to other models. With an estimated R² value of 0.692, approximately 69% of the variations in maize yield are explained by access to microcredit and other socio-economic factors. The model demonstrates a strong fit for the data, with a substantial portion of the variability in maize yield accounted for by the explanatory variables. This indicates that the included variables capture a significant portion of the variability in maize yield within the study area.

Table 5. Effect of Microcredit and other socio-economic variables on the yield of maize.

Variables	Coefficient	t-ratio	Sig.
Constant	1.984	0.69	0.490
Microcredit	2.750***	9.170	0.000
Age	2.311	0.61	0.546
Sex	3.397**	2.31	0.023
Education	-1.120	-0.78	0.436
Household size	-0.186**	-2.45	0.016
Farm size	1.169***	10.05	0.001
Experience	0.003*	1.82	0.071
Association membership	3.264*	1.68	0.096
Extension contact	0.991	-0.19	0.851
R ²	0.692		
Adj. R ²	0.611		
F value	32.626		

Note: ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

The analysis reveals several significant factors influencing maize yield among farmers with access to microcredit in the study area. Access to microcredit ($p < 0.01$) had a positive and statistically significant impact on maize yield, indicating that enhancing microcredit acquisition can improve yield and increase income generation for maize farmers. This observation underscores the importance of facilitating access to microcredit as a means to enhance agricultural productivity and livelihoods. Furthermore, the coefficient of sex shows that male farmers who had access to microcredit experienced higher maize yields, highlighting the gender dimension in agricultural productivity. Additionally, farm size positively influences maize yield among farmers with access to microcredit, emphasizing the significance of sufficient land for production. The finding corroborates the results of Abdallah [26] and Ojo, et al. [27] who found a positive relationship between farm size and crop yield. Years of maize farming experience also play a significant role in influencing maize yield, indicating that experienced farmers are better positioned to leverage microcredit for increased productivity. This result corroborates the findings of Nouman, et al. [28] that a positive relationship exists between access to microcredit, years of farming experience, and income of farmers. Membership in maize farmers' associations positively affects maize yield, suggesting that belonging to such groups enhances access to microcredit and fosters knowledge exchange and adoption of innovative practices. This agrees with the findings of Kassie, et al. [29] that farmers' groups provide a platform for members to exchange valuable information regarding farming practices and share diverse experiences about new technologies during their meetings. Conversely, household size ($p < 0.05$) was found to have a significant negative relationship with maize yield. This implies that larger household sizes are associated with lower maize yields among farmers with access to microcredit. This suggests potential challenges in managing resources and labour within larger households, which may negatively impact agricultural productivity. This finding contradicts previous studies by Kehinde and Ogundeji [30] but underscores the complex interplay of socio-economic factors in agricultural productivity.

4. Conclusion and Recommendations

The study concluded that access to microcredit matters in the adoption of climate change adaptation strategies as well as maize yield in the study area. The study revealed that access to credit led to increased adoption of climate change adaptation strategies and higher maize productivity. Therefore, implementing accessible and affordable microcredit schemes could be a strategic move for policymakers and stakeholders to prioritize in supporting farmers and fostering resilience in the face of climate challenges. This will enable farmers to access the necessary resources for implementing climate change adaptation strategies and improving maize productivity. Additionally, financial institutions, including the Bank of Agriculture, should be encouraged to establish more rural outlets to improve farmers' access to credit. This expansion will ensure that rural farmers have convenient access to financial services, including agricultural credit. Furthermore, farmers' associations, which can serve as platforms for collective action, knowledge exchange, and access to financial resources, thereby enhancing farmers' adaptive capacity, should be encouraged and strengthened to provide microcredit to farmers in the study area.

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