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THE IMPACT OF CLIMATE CHANGE ON THE PROFITABILITY OF AGRICULTURAL SMALL-SCALE ENTERPRISES IN NIGERIA

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Abstract: *Climate change poses significant challenges to agricultural productivity, particularly for small-scale enterprises. This study investigates the impact of climate change on the profitability of small-scale farm enterprises in Nigeria. A descriptive survey design was employed, with data collected from a sample of 243 respondents, 217 of which were retrieved and usable with a structured questionnaire. The findings reveal a strong positive correlation between temperature variation and financial performance, suggesting that increased temperature can, under certain conditions, positively impact agricultural productivity. However, extreme temperature events can have detrimental effects.*
A strong positive correlation was also found between favourable rainfall patterns and financial performance. The study highlights the need for climate-smart agricultural practices, diversified production systems, and supportive policies to mitigate the negative impacts of climate change on small-scale agrarian enterprises. Future research could delve deeper into the mechanisms underlying the relationship between climate variables and financial performance, explore the regional variations in climate impacts, and assess the effectiveness of different adaption and mitigation strategies.

Keywords: *Agricultural productivity, Climate change, Financial performance, Profitability, Rainfall patterns, Temperature variation.*

Introduction

Small-scale enterprises often face market failures and economic constraints, such as high input costs and limited market access, dampening profitability. For example, the fishery value chain in Nigeria is affected by segmented markets and high labour costs (Chikte et al., 2024). While small-scale agricultural enterprises face numerous challenges, they also have opportunities for growth and increased profitability through strategic resource management, innovation, and supportive policies. However, the volatility in profitability due to external economic factors, such as inflation and market dynamics, remains a significant

concern, necessitating adaptive strategies and continuous support from stakeholders (Olukunle, 2017; Hyuha et al., 2011).

Numerous factors, such as financial limitations, resource allocation, and market dynamics, affect the profitability of small-scale agricultural operations (Tugga et al., 2023). These firms are essential to rural economies by generating employment and enhancing food security (Jablonski et al., 2022). Nevertheless, restricted access to resources and market inefficiencies frequently impede their viability. Factors such as enterprise age, manager education level, and record-keeping practices significantly influence profitability. Older enterprises with experienced managers and robust record-keeping systems tend to be more profitable (Endris & Kassegn, 2023a; Endris & Kassegn, 2023b). Availability of inputs and access to credit are critical for profitability. Enterprises with better access to these resources can achieve higher profitability by optimising production processes (Endris & Kassegn, 2023a; Endris & Kassegn, 2023b).

Financial performance is a critical measure of profitability for agricultural small-scale enterprises, as it provides insights into their economic viability and sustainability (Mukaila, 2023). Numerous factors, including financial management methods, firm size, and external economic conditions, affect the profitability of these enterprises. Understanding these factors can help enhance the performance and longevity of small-scale agricultural businesses. Effective financial management practices, including working capital management and accounting information systems, are crucial for enhancing profitability (Roy et al., 2023).

Climate change significantly impacts agricultural small-scale enterprises in Nigeria, affecting productivity, income, and adaptation strategies (Akuwudike et al., 2024). The changing climate, characterized by increased temperatures and altered precipitation patterns, poses challenges to agricultural productivity and the livelihoods of small-scale farmers. These enterprises, which form a substantial part of Nigeria's economy, are particularly vulnerable due to limited resources and adaptive capacity. Climate change has led to a decrease in agricultural productivity, with a 15% increase in harmful degree days resulting in a 5.22% reduction in productivity (Amare & Balana, 2023). Small-scale farmers have adopted various strategies to cope with climate change, such as changing crop varieties, implementing soil conservation techniques, and adjusting planting dates (Thompson et al., 2023).

Temperature variation and rainfall patterns are critical dimensions of climate change, influencing environmental, economic, and social systems globally (Garcia et al., 2014). These changes manifest in diverse ways across different regions, affecting water resources, agriculture, and even public health. Temperature increases are a prominent manifestation of climate change, leading to intensified air cycles and shifts in climatic regions. This results in more frequent extreme weather events and altered heat distribution globally (Aleedani et al., 2024). In Nigeria, a significant upward trend in temperature has been observed, with a mean temperature of 27.7 °C over 32 years, indicating a clear impact of climate change (Odiana & Ochulor, 2024). Rainfall patterns are becoming increasingly irregular, with significant spatial and temporal variations. In Iraq, the Precipitation Concentration Index (PCI) indicates strongly irregular rainfall, with notable dry and wet years identified over a 40-year period (Tehreem et al., 2022).

Ahatsi et al. (2024) explored climate change mitigation and adaptation in Ghana, focussing on the tactics and challenges encountered by social businesses. Nkansah-Dwamena (2024) analysed the significance of small-scale circular agriculture for food security and

environmental sustainability in Sub-Saharan Africa. The situation in Ghana; Rehman et al., (2024). Climate change and food security in South Asia: the significance of renewable energy and agricultural financing; Umer et al., (2024). A assessment of small-scale irrigation farming as a climate-smart agricultural technique, its adoption, and its impact on food security for Ethiopian smallholder farmers: Touch et al., (2024). Challenges and possibilities faced by smallholder farmers: Implications for agricultural production, the environment, and food security; Umer et al., 2024. A evaluation of small-scale irrigation farming as a climate-smart agricultural technique, its adoption, and its influence on food security for Ethiopian smallholder farmers.

The present study reveals a dearth of scholarly information pertaining to the climate change on the profitability within Agricultural small-scale enterprises in Nigeria. This conclusion is drawn from an analysis of the aforementioned studies and the reviewed literature.

Aim and Objectives of the Study

The aim of the study is to examine the impact of climate change on the profitability of Agricultural small-scale enterprises in Nigeria. Thus, the following specific objectives are stated:

- To investigate the relationship between temperature variation and financial performance of Agricultural small-scale enterprises in Nigeria.
- To evaluate the relationship between rainfall patterns of Agricultural small-scale enterprises in Nigeria.

Research Hypotheses

H_{01}: There is no significant relationship between temperature variation and financial performance of Agricultural small-scale enterprises in Nigeria.

H_{02}: There is no significant relationship between rainfall patterns and financial performance of Agricultural small-scale enterprises in Nigeria.

Climate Change

Climate change (CC) is a multifaceted worldwide concern that affects numerous aspects of ecological, environmental, socio-political, and socio-economic domains (Adger et al. 2005; Leal Filho et al. 2021; Feliciano et al. 2022). Climate change entails increased temperatures in several regions (Battisti & Naylor 2009; Schuurmans 2021; Weisheimer & Palmer, 2005; Yadav et al. 2015). The advent of the industrial revolution significantly exacerbated the issue of Earth's climate (Leppänen et al. 2014).

Climate change is defined by extensive long-term changes in temperature and precipitation, as well as other factors such as atmospheric pressure and humidity levels in the environment. Furthermore, erratic weather patterns, the retreat of global ice sheets, and the resultant rise in sea levels are prominent international and domestic consequences of climate change (Lipczynska-Kochany 2018; Michel et al. 2021; Murshed & Dao, 2020). Prior to the industrial revolution, natural phenomena, including volcanic eruptions, wildfires, and seismic events, were perceived as the primary sources of greenhouse gases (GHGs) such as CO2, CH4, N2O, and H2O released into the atmosphere (Murshed et al. 2020; Hussain et al. 2020; Sovacool et al. 2021; Usman & Balsalobre-Lorente 2022; Murshed 2022).

Temperature Variation

Temperature variation, a significant aspect of climate change, has a profound impact on agricultural small-scale enterprises in Nigeria. Rising temperatures can directly affect crop yields and quality. Heat stress can reduce crop productivity, especially for heat-sensitive crops like maize, rice, and wheat. Additionally, higher temperatures can create favourable conditions for pests and diseases, leading to increased crop losses.

Temperature variation, encompassing fluctuations on daily, seasonal, and interannual scales, significantly impacts both ecological systems and economic activities (Vasseur et al., 2014). The effects of temperature variability are multifaceted, influencing economic development, species interactions, and disease dynamics. This complexity necessitates a nuanced understanding of how temperature changes affect various systems.

Day-to-day temperature variability has a negative effect on economic activity, as evidenced by satellite data on nightlights, which serve as a proxy for economic activity. Seasonal variability also negatively impacts economic performance, albeit to a lesser extent. Interannual variability can have mixed effects, being beneficial at low temperatures but detrimental at high temperatures (Linsenmeier, 2023).

Temperature variability affects predator-prey dynamics, potentially leading to outcomes ranging from predator collapse to stable coexistence. These effects depend on the interaction strengths and thermal performance differences between species (Dee et al., 2020). In host-parasite interactions, temperature fluctuations can alter infection rates and pathogen burdens. For instance, diurnal temperature fluctuations reduced infection rates in Daphnia magna, while heatwaves had varying effects depending on the mean temperature (Wang et al., 2022).

Rainfall Patterns

Rainfall patterns are complex phenomena influenced by various factors, including temporal distribution, geographical location, and climate change (Lee, 2015). Understanding these patterns is crucial for effective water resource management, flood forecasting, and agricultural planning.

The study by Oh et al., (2024) introduces indices like skewnessPEAK and NRMSEp to quantify the temporal distribution of rainfall and its impact on flood discharge. Concentrated rainfall near the peak significantly increases discharge, while earlier peak rainfall reduces it, highlighting the importance of these indices in flood forecasting models.

Zhang et al. explore the influence of rainfall patterns on poverty in Sub-Saharan Africa, revealing that extreme rainfall and variability significantly affect household wealth, particularly in impoverished communities. This underscores the socio-economic implications of changing rainfall patterns due to climate change (Zhang et al., 2024).

Chen et al. discuss the impact of design rainfall patterns on urban flooding, using the Chicago method to simulate different scenarios. The study finds that the recurrence period and peak ratio significantly influence water accumulation and inundation extent, informing urban flood management strategies (Fu et al., 2023).

Profitability

Profitability is an essential metric assessing a company's capacity to produce income in relation to its expenses and other incurred costs over a defined timeframe (Alarussi & Alhaderi, 2018). It serves as a key indicator of financial health and operational efficiency,

influencing investment decisions and corporate valuation. Various factors, both internal and external, can significantly impact profitability, and understanding these can help businesses optimize their financial performance.

A shorter cash conversion cycle can enhance profitability by reducing the time capital is tied up in the business process. However, a longer cycle can negatively impact profitability, as seen in the container and packaging industry in Indonesia (Kulwizira Lukanima, 2023). Elevated liquidity, frequently assessed through the current ratio, enhances profitability by guaranteeing that a company can fulfil its short-term liabilities and capitalise on development prospects (Kulwizira Lukanima, 2023).

Ratios like return on assets (ROA) and return on equity (ROE) are essential for evaluating profitability. These ratios offer insights into a company's efficacy in utilising its assets and equity to generate profits (Suryani & Mardiana, 2022; Kulwizira Lukanima, 2023). Profitability may mediate the influence of capital structure and company size on firm value, underscoring its significance in augmenting corporate valuation (Barbero & Zofío, 2023). It also directly impacts stock returns, emphasizing its importance in investment decisions (Singhal et al., 2024).

Financial Performance

Financial performance serves as an indicator of an organization's current progress and possible expansion (Le Thi Kim et al., 2021). Consequently, assessing a business's financial performance is of paramount importance and occupies a significant amount of focus (Pasko et al., 2020). Profit is the most prevalent financial performance metric and the primary objective that a corporation endeavours to attain (Yeniyurt, 2003).

Financial indicators elucidate many dimensions of business performance that assist decision-makers in evaluating whether the organisation is creating value for its stakeholders. This metric originates from the domains of accounting, financial management, and economics (Attiea et al., 2014). This entails assessing metrics including earnings, sales growth, revenues, and return on investment (Johansson et al., 2008; Rauch et al., 2009). Financial performance and accounting metrics of profitability are widely acknowledged as essential markers for delineating and evaluating company success (Rowe & Morrow, 2009; Santos & Brito, 2012; Arshad et al., 2013). Companies frequently employ profitability and growth metrics to evaluate their financial performance. Profitability is a measure of a company's past ability to generate profits, whereas growth reflects a company's historical capability for expansion. Expanding the scale, even without changing the level of profitability, will result in a higher amount of profit and cash flow. Increased sizes can also lead to cost advantages and market dominance, resulting in enhanced future profitability (Santos & Brito, 2012).

Theoretical framework

Vulnerability Theory

Vulnerability theory, as conceptualized by Martha Fineman, is a framework that emphasizes the inherent and universal nature of human vulnerability and the role of institutions in addressing it (Küçüksu & Ünüvar, 2023). This theory challenges traditional notions of autonomy and self-sufficiency by highlighting the need for a responsive state that ensures substantive equality. It has been applied across various domains, including social welfare,

legal history, and corporate law, to advocate for policies that recognize and mitigate vulnerabilities.

Fineman's theory posits that vulnerability is a constant and universal condition, affecting all individuals regardless of their social status. This challenges the liberal notion of the autonomous individual and calls for a shift towards recognizing the vulnerable subject as central to legal and social policy (McCluskey, 2016).

This theory directly addresses the susceptibility of marginalised groups, such as small-scale farmers, to climate-related risks. It highlights the specific challenges they face, including limited resources, lack of access to technology, and dependence on climate-sensitive livelihoods. While vulnerability theory offers a strong theoretical foundation, it also has limitations. It is a complex concept with multiple dimensions, making it challenging to measure and quantify. Additionally, data availability on vulnerability, particularly at the local level can be limited.

Despite these limitations, vulnerability theory remains highly relevant to the study. It helps identify vulnerable groups, analyse exposure and sensitivity to climate hazards, assess adaptive capacity, and inform policy interventions. By applying this theory, researchers can gain a deeper understanding of the challenges faced by small-scale farmers and develop effective strategies to support their livelihoods and food security in the face of climate change.

Methodology

This research employed a descriptive survey design to investigate the impact of climate change on the profitability of small-scale agricultural enterprises in South-South, Nigeria. The study population comprises 243 such enterprises, the study adopted the population as the sample size (census study). Data collection relied on a structured questionnaire, divided into sections for demographic information and questions about the impact of climate change on various aspects such as temperature variation, rainfall patterns and financial performance. The questionnaire was pilot-tested before being administered to the selected sample. Data analysis involved descriptive statistics to characterize the sample and the observed impacts of climate change. The Spearman Rank Order Correlation Coefficient was used to quantify the strength and direction of relationships between climate change variables and enterprise profitability. Ethical considerations was paramount, including obtaining informed consent from participants, maintaining confidentiality, and ensuring data privacy. This research aims to provide valuable insights into the challenges faced by small-scale agricultural enterprises in Nigeria due to climate change, thereby informing policy decisions for mitigation and adaptation.

Result and Discussions

Descriptive statistical analysis enables the extraction of demographic information related to the respondents in the sample. This study entailed statistical analysis of the collected sample data, resulting in the descriptive statistics in Table 1. Of the 243 samples, only 217, constituting 89.3%, were retrieved and deemed suitable for the investigation.

Table 1: Descriptive statistical analysis (N = 217)

Characteristics	Option	Frequency	Percentage
Gender	Male	128	58.98%
	Female	89	41.01%
Age	25-30 years old	26	11.98%
	31-40 years old	106	48.85%
	41-50 years old	85	39.17%
Education	SSCE/WAEC	74	34.10%
	B.Sc.	139	64.06%
	Masters or above	4	1.84%
Marital Status	Single	70	32.26%
	Married	147	67.74%

The descriptive analysis provides an overview of the sample characteristics for the study on the impact of climate change on small-scale agricultural enterprises in Nigeria. Table 1 summarizes the distribution of respondents across various demographic categories. The majority of the respondents (58.98%) are male, while 41.01% are female. This implies that the predominance of male farmers may reflect traditional gender roles in agriculture, where women often have limited access to land, resources, and decision-making power. The age group with the highest representation is 31-40 years old (48.85%), followed by 41-50 years old (39.17%) and 25-30 years old (11.98%). The significant proportion of farmers aged 31-40 suggests a balance between experienced and younger, potentially more innovative farmers. A large portion of the respondents (64.06%) hold a Bachelor's degree (B.Sc.), while 34.10% have a secondary school certificate (SSCE/WAEC), and only a tiny percentage (1.84%) have a Master's degree or higher. The relatively high level of education among the respondents indicates a potential for adopting new technologies and practices to mitigate the impacts of climate change. Most respondents (67.74%) are married, and 32.26% are single. Most farmers being married suggests that family labor may play a significant role in agricultural activities. This descriptive analysis provides a preliminary understanding of the sample composition and can be used to assess potential biases or limitations in the generalizability of the findings.

TESTING OF RESEARCH HYPOTHESES

H_{01}: There is no significant relationship between temperature variation and financial performance

Table 2: Analysis of the effect of *temperature variation (TVN)* on *financial performance (FPE)*

Correlations

			TVN	FPE
Spearman's rho	TVN	Correlation Coefficient	1.000	.859
		Sig. (2-tailed)	.	.000
		N	217	217
	FPE	Correlation Coefficient	.859	1.000
		Sig. (2-tailed)	.000	.
		N	217	217

Source: SPSS 27.0 output on research data

Table 2 presents the result of the test of the hypothesis of no significant relationship between temperature variation and financial performance. The correlation coefficient of 0.859, coupled with a statistically significant p-value of 0.000, indicates a strong positive relationship between temperature variation and the financial performance of small-scale agricultural enterprises in Nigeria. This suggests that as temperature variation increases, the financial performance of these enterprises tends to improve. The null hypothesis was rejected based on the evidence presented.

Hypothesis Two

H_{02}: There is no significant relationship between rainfall patterns and financial performance

Table 3: Analysis of the effect of *rainfall patterns (RFP)* on *financial performance (FPE)*

Correlations

			RFP	FPE
Spearman's rho	RFP	Correlation Coefficient	1.000	.797
		Sig. (2-tailed)	.	.000
		N	217	217
	FPE	Correlation Coefficient	.797	1.000
		Sig. (2-tailed)	.000	.
		N	217	217

Source: SPSS 27.0 output on research data

Table 3 presents the result of the null hypothesis that no significant relationship exists between rainfall patterns and financial performance. The correlation coefficient of 0.797 and a statistically significant p-value of 0.000 suggest a strong positive relationship between rainfall patterns and the financial performance of small-scale agricultural enterprises in Nigeria. This implies that as rainfall patterns become more favourable, the financial

performance of these enterprises tends to increase. Based on the evidence presented, the null hypothesis was rejected.

Discussions of Findings

The statistical analysis was conducted using Spearman's Rank Correlation Coefficient in SPSS version 27.0. The results indicate a substantial association between temperature variation and financial performance, supporting hypothesis 1. Temperature variation significantly impacts the financial performance of small agricultural enterprises in Nigeria, primarily due to its influence on crop yields and market dynamics (Aladelokun et al., 2020). The agricultural sector, which is crucial for Nigeria's economy, faces challenges from climate change, affecting the efficiency and profitability of small-scale enterprises. These enterprises are vital for economic growth and employment but are vulnerable to environmental changes. Climate change, including temperature variations, affects the efficiency and profitability of small-scale agricultural enterprises. For instance, excessive rainfall, a consequence of climate change, has decreased profit efficiency among chili pepper marketers in Benue State, Nigeria (Phil Chibuikem, 2022). The agricultural sector's perceived riskiness due to climate change leads to inadequate funding, as financial institutions prefer sectors with shorter payback periods and higher returns (Folajinmi & Peter, 2020).

Hypothesis 2 demonstrates a statistically significant correlation between rainfall patterns and financial performance. Rainfall patterns significantly influence the financial performance of small agricultural enterprises in Nigeria, primarily due to their impact on agricultural productivity and resource availability (Eludoyin et al., 2017). Variability in rainfall, exacerbated by climate change, affects crop yields and livestock production, which in turn influences the economic viability of these enterprises. This relationship is further complicated by the financial challenges faced by small-scale agricultural enterprises, including inadequate funding and financial risks. Rainfall variability, particularly in Northeastern Nigeria, has reduced pastureland and water resources, adversely affecting livestock production and agricultural output (Adeshina et al., 2020). The lack of consistent rainfall patterns necessitates adaptive strategies such as migration and changes in agricultural planning to mitigate the impact on economic activities (Adeshina et al., 2020). Agricultural financing in Nigeria is inadequate, with limited government support and financial institutions perceiving the sector as risky (Onakoya & Onakoya, 2013; Phil Chibuikem, 2022). Small-scale enterprises face significant financial risks, including exchange rate and interest rate fluctuations, which negatively impact their performance (Folajinmi & Peter, 2020). Despite these challenges, micro-credit schemes have emerged, offering credit facilities without collateral, although their effectiveness varies (Aderemi et al., 2019).

Conclusion

The research on the impact of climate change on small-scale agricultural enterprises in Nigeria has unveiled significant insights into the intricate relationship between climate variability and agricultural productivity. The findings demonstrate a strong positive correlation between temperature variation rainfall patterns and financial performance. While a warmer climate may, in certain instances, benefit crop growth and extend growing seasons, extreme temperature events like heatwaves and cold spells can adversely impact crop yields and livestock productivity. Similarly, favourable rainfall patterns are crucial for

agricultural success. However, extreme rainfall events such as floods and droughts can disrupt agricultural activities, leading to substantial economic losses.

A comprehensive approach is necessary to mitigate the adverse effects of climate change. This includes promoting climate-smart agricultural practices, encouraging crop and livestock diversification, providing financial support to farmers, establishing early warning systems, promoting agricultural insurance, and implementing supportive policies. Addressing the challenges posed by climate change can enhance the resilience of small-scale agricultural enterprises and ensure food security for Nigeria's growing population.

Recommendations

Based on the aforementioned debates and results, the present study puts up the following suggestions about the correlation between the impact of climate change on the profitability of Agricultural small-scale enterprises in Nigeria.

i. A multifaceted approach is necessary to mitigate the negative impacts of temperature variation on the financial performance of small-scale agricultural enterprises in Nigeria. Policymakers should prioritize developing and implementing climate-smart agricultural policies that promote adaptation and mitigation measures. Increased investment in agricultural research is crucial to developing climate-resilient crop varieties and innovative farming techniques. Strengthening extension services can equip farmers with the knowledge and skills to adopt climate-smart practices.

ii. A comprehensive approach is necessary to mitigate the negative impacts of unpredictable rainfall patterns on the financial performance of small-scale agricultural enterprises in Nigeria. Policymakers should prioritize developing and implementing climate-smart agricultural policies that promote climate-resilient agricultural practices. Increased agricultural research investment is crucial to developing drought-tolerant and flood-resistant crop varieties. Strengthening extension services can equip farmers with the knowledge and skills to adopt climate-smart practices, such as water harvesting, efficient irrigation, and soil moisture conservation techniques.

iii. At the farmer level, diversifying crop portfolios can reduce vulnerability to temperature fluctuations. Efficient irrigation systems and water conservation practices can mitigate the impact of water scarcity. The adoption of heat-tolerant and drought-resistant crop varieties can enhance resilience. Agroforestry practices can provide shade and improve soil moisture. Early warning systems can alert farmers about impending heatwaves or cold spells, allowing them to take timely preventive measures. Community-based adaptation approaches can foster collective action and knowledge sharing.

iv. Financial incentives, such as subsidies and low-interest loans, can encourage the adoption of climate-resilient technologies and practices. Climate-informed insurance products can protect farmers against losses due to rainfall variability.

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