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Research Article

Assessment of the financial impact of climate-induced extreme weather events on smallholder crop farmers and agricultural insurance companies

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ABSTRACT

This study assesses the financial impact of climate-induced extreme weather events on smallholder crop farmers and agricultural insurance firms in Lagos State, Nigeria. Statistical methods employed include descriptive statistics (frequencies, means, percentages), cross-tabulation, Likert-scale analysis, and simple linear regression to assess the relationship between claims and firm solvency. Using a descriptive and inferential statistical analysis of data from a survey of 180 smallholder farmers and 40 staff from four general insurance companies, the study found that severe storms were the most frequent extreme weather event, confirmed by 65.0% of respondents. Storms were also the most financially damaging, causing an average crop loss of ₦87,544.44 per farmer. The overall uptake of agricultural insurance among farmers was found to be 52.8%, with a gender disparity showing male farmers had a higher purchase rate (59.0%) than female farmers (47.4%). Affordability of premiums was identified as the most significant barrier to accessibility, with the lowest mean score (2.94) on a Likert scale. Insurance firms were found to offer a variety of products, with a high proportion offering crop insurance (72.5%) and farm asset insurance (72.5%), but a notable gap in the availability of more modern solutions like weather-index insurance (only 45% of firms offered it). The analysis further revealed a very strong positive correlation between the financial impact of claims and the solvency of insurance firms. Key challenges identified by insurers were pricing difficulties and high administrative costs, which were consistently perceived as the most significant challenges. The study concludes with the finding that these climate-induced financial risks have a direct and significant impact on both smallholder farmer livelihoods and the solvency of agricultural insurance providers.

Keywords: Climate-Induced Weather, Extreme Weather Events, Smallholder Crop Farmers, Agricultural Insurance

1. Introduction

Agriculture is the mainstay of the Nigerian economy in terms of providing employment, food security and livelihoods especially in the rural areas (World Bank, 2022; Food and Agriculture Organization [FAO], 2021). The rural population of the country is more than 70%, with a vast majority of them being smallholder farmers as they supply most of the food in the country (International Fund for Agricultural Development [IFAD], 2020). Nevertheless, the industry is rather sensitive to climatic fluctuations and extreme weather that are related to droughts, floods, heatwaves, and storms. Such occurrences are escalating with more frequency and severity, and they are largely being catalyzed by global climate change (IPCC, 2021). This has significant impacts on agricultural productivity, the livelihoods of households and the overall stability of agriculture Okunlola & Ayetigbo, 2024).

Extreme weather is a serious threat to the agricultural production, since it destroys crops, leads to diminished harvests, and to deterioration of agricultural lands. Most recently, Nigeria has experienced destructive floods in the south-central and southern states, and the repetitive droughts experienced in arid regions in the north (NEMA, 2022). Such climatic disturbances are known to bring about sudden decrease in incomes, food insecurity, indebtedness, and

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loss of assets. Many farmers especially those farming on marginal lands and with limited access to financial facilities can be pushed further into depths of poverty by just having one extreme event happening to them (Federal Ministry of Environment, 2021). The loss of crops, livestock, and the most vital facilities further increased the food inflation that exceeded 24.1% in 2023 (NEMA, 2022; NBS, 2023) — a year specifically cited because it recorded the highest food inflation on the National Bureau of Statistics records within the 2020–2024 study period, making it the most recent data point available at the time of writing. Also, shifting seasons have taken place, shortening growing seasons of B heat-sensitive crops such as maize and millet and, in some areas, cutting crop yields by almost 20% (Tonnang et al., 2022).

Among the key aspects of this fact, the solvency of farming households should be mentioned. Solvency is a key element in the economic well-being and in economic stability, as well as perpetuation of investment in agriculture. The successive occurrence of climate shocks undermines the financial viability of farmers, in terms of cash flows, reliance on financing, and approaching the reinvestment of a future production cycle (DeLay et al., 2023). In cases where financial shocks are not well sustained with adequate safety nets, farmers can be left with no choice but to sell off productive assets, quit farming or even migrate making the rural economy more fragile.

Since weather-related shocks are inevitable, agricultural risk management has become a priority to the policymakers and the development practitioners as well as the financial institutions. Agricultural insurance is one of the most important risk transfer techniques because it is intended to cover farmers against losses to their crops when losses happen due to natural hazards that are beyond the farmer to control. In Nigeria, agricultural insurance is at a nascent stage of development and there remains low penetration and rural awareness levels. Nigerian Agricultural Insurance Corporation (NAIC) and a few private insurers provide crop, livestock and index based insurance products. Nevertheless, the level of uptake is low because of many factors including affordability, lack of trust, bad product design, and poor delivery channels.

Agricultural insurance is a crucial tool for risk management in the farming sector, providing a financial safety net against a variety of perils. Research has shown that agricultural insurance can play a significant role in improving the economic resilience of rural households, particularly in the face of natural disasters (Xie et al., 2024). It's also been found to stabilize farm incomes and encourage the adoption of new, higher-yielding but riskier technologies (Kramer et al., 2022). Furthermore, studies have demonstrated a positive impact of agricultural insurance on farmers' income, as seen in the case of China's Guangdong Province (Bhuiyan et al., 2022). This body of work underscores that agricultural insurance is not merely a compensatory tool but also a catalyst for economic development and stability within the agricultural sector. The purpose of this insurance is to transfer risk from the farmer to an insurer in exchange for a premium (Vyas et al., 2021).

Despite its established benefits, the literature highlights ongoing challenges and the evolving role of agricultural insurance. A key issue is the low uptake of insurance, particularly in developing countries, with factors such as low awareness, lack of trust in providers, and high costs being major barriers (Nshakira-Rukundo et al., 2021). Interestingly, some studies have also explored the unintended consequences of insurance. For example, research from China suggests that while agricultural insurance has positive economic effects, it may also lead to an increase in agricultural fertilizer non-point source pollution, highlighting a potential trade-off between economic benefit and environmental sustainability (Niu et al., 2022). This body of literature collectively argues for innovative product designs, better data collection, and robust public-private partnerships to make agricultural insurance more effective and equitable.

The fact that insurance firms have little impact in cushioning farmers against climatic risks makes empirical research important. While much attention has been given to the physical impacts of climate change on agriculture, there is a relative paucity of research on the financial implications of these risks, particularly how extreme weather affects farmers' financial exposure and solvency, and the extent to which insurance firms play a mitigating role (National Bureau of Statistics [NBS], 2021). Lacking a strong appreciation of such dynamics, designing effective interventions is hard to come by and on the one hand to safeguard the incomes of farmers, on the other hand to maintain their financial health and to enhance agricultural resilience (IPCC, 2021).

1.1. Statement of the Research Problem

Nigeria's agricultural sector constitutes a foundational pillar of the national economy, directly accounting for approximately 24% of GDP and supporting the livelihoods of over 70% of the rural population. However, agriculture

is increasingly under attack by an extreme weather event provoked by climate change. Much of the national GDP (24%) and much of the rural labour force (over 70%) is dependent on the sector, making it acutely susceptible to climatic influences that can carry over to compromised food security, economic resilience, and insurance solvency. The rising rate and intensity of floods, droughts, heat waves and unpredictable rain falls, which are associated with global warming (IPCC, 2021) have interfered with the agricultural production cycles, ruined farmlands, and destabilized rural economies (NEMA, 2022; Adah et al., 2016). Although physical consequences of such events have been well-reported, the implications related to their impacts on agricultural insurance systems that serve a pivotal role in mitigating agricultural financial losses and resilience of farmers, remain to be critically filled. Against this backdrop, this study positions its inquiry at the intersection of climate-induced agricultural loss and the financial resilience of insurance institutions designed to absorb such shocks.

One is the lack of empirical study on particular extreme weather events that exacerbate agricultural exposure to risk in Nigeria. While hazards Li et al. (2021), indicates that the heat waves, floods and drought are the main, their spatial variability, temporal regime, and inter-related effects (e.g. simultaneous heat waves and soil degradation) are poorly studied. As an example, lengthy droughts in the Sahelian areas of Nigeria have decreased ground water availability by up to 40%, contributing to issues with irrigation, as well as flooding along the coastlines of the Niger Delta that have led to a rise in salinity intrusion which has increased soil salinity in 15% of arable land.

Second, the effects on agricultural insurance obviously depend on the impacts of extreme weather on the risk and exposure. Nigerians insure far less of their agricultural produce (less than 2%), partly because available schemes lack liquidity, as they have to face the frequent, large pay-outs (Ajayi & Adeleke, 2021). In one example, post-flood claims in 2022 were 30% more than NAIC annual risk capital, which was a threat to solvency (NAIC, 2023). However, little work analyses the relationship between actuarial risk and weather impacts, such as crop failure due to weather, loss of livestock in response to weather, and delays to the planting season. Pingali (2017) emphasize that older indemnity-based models are inappropriate when it comes to climate volatility but Nigeria-specific alternatives have not been researched yet.

Third, it is poorly understood how extreme weather events impact the duration of the event on the insurance risk that has been exposed. Short-term shocks like flash floods are a stark contrast to long term shocks like droughts in terms of financial impacts. Likewise, routine droughts lasting 12 months in Northern Nigeria have been linked with cutting down the yield of maize by half, which provokes delays in filing the outstanding debts by farmers over several consecutive years (Adepoju et al., 2024). On the other hand, floods can be episodic leading to immediate asset loss but short recovery. Existing actuarial models have tended to reduce the duration of events to a few homogenous categories that cause a distorted premium and reserve (Ajemunigbohun & Abdul-Azeez, 2023). This miss creates a hurdle to building duration-sensitive insurance structures that would increase solvency.

Fourth, little has been addressed as far as measures mitigating the financial effects of extreme weather on the agricultural insurance frameworks are concerned. Adaptive coping mechanisms such as index-based insurance and the use of climate-resilient infrastructure are promoted worldwide, but cannot apply to the situation in Nigeria due to a lack of data, farmer ignorance, and institutional weakness (Ajayi & Adeleke, 2021). To provide an example, satellite-based index insurance initiatives in Kano State lowered the level of claim contention by 25% but had a low uptake because of affordability issues around premiums (Oluwatimilehin & Ayanlade, 2023). In Nigeria, the National Agricultural Resilience Framework (NARF) also places an importance on diversification and early warning systems, although not much has happened yet, with only 10% of farmers using climate advisory services (FMEnv, 2020).

The prominent position of agriculture as the core of the economy and at-risk climate emphasize the necessity of creating adaptive measures. Although the National Agricultural Resilience Framework (NARF) is put in place to address resilience-building, there are still implementations shortfalls especially on farmers who are smallholders who are not given access to technology, finance, and infrastructure (Federal Ministry of Agriculture, 2019). The paper is set against this background in order to evaluate the financial effect of the extreme weather events on agricultural insurance exposure risk of loss and solvency. In addressing these gaps empirically, this study will contribute to policy platforms that are capable of preserving economic stability as well as food security at a time when climate is rapidly changing.

1.2. Research Questions

The following research questions guided this study:

- i. What are the socio-demographic characteristics of the crop farmers and the demographic characteristics of the insurance firms?
- ii. What are the types of extreme weather events affecting crop production in the study area?
- iii. What is the level of risk exposure of crop farmers to climate-induced disasters?
- iv. What are the financial losses incurred by farmers as a result of extreme weather events (2020–2024)?
- v. What is the accessibility and uptake of agricultural insurance?
- vi. What is the volume of claims due to agricultural risks (2020–2024)?
- vii. What is the financial impact of claims on insurance firm solvency?
- viii. What are the challenges faced by insurance firms?

2. Conceptual Framework

2.1. Agricultural Insurance

Agricultural insurance and risk management is one of the major elements in the modern farming activity, especially as the rise of uncertainties in farming occurs through global warming. Agricultural insurance, as an important element of green agriculture, is a kind of monetary instrument intended to guarantee the immunity of farmers, agribusinesses, and economies with the negative effects of the risks of production, natural catastrophes, and shockwaves (Smith & Glauber, 2012). There have been increased complexities in the global agricultural system, which has prompted new methods of risk managing (Alli, 2024). The historical ways of responding to agricultural losses, either through informal savings or through state assistance, do not usually work to resolve the magnitude and occurrence of contemporary disturbances (Adah et al., 2016). Agricultural insurance makes up the difference by offering an arranged procedure to disperse the risk to insurers or pools of risk where the income levels are moderated, and future planning is capable of being carried out. Nonetheless, agricultural insurance success depends on how it is designed and made available and relates to local contexts, which differ between regions and farming systems (Nshakira-Rukundo et al., 2021).

The risk exposure entails the risks that the insurance companies as well as insured agents, experience certain losses following the uncertainties in agricultural production (Wang et al., 2022). The causes of such risks may be natural disasters, market forces, policy alterations, or inefficiencies in operations (Pratiwi & Budiasa, 2022). According to Sun and other scientists (2024), weather-indexed products are needed due to climate variability because it has been observed to be one of the greatest contributors to risk exposure. According to Zeng et al. (2022), it is notable that systemic risks improve the significance of the understanding of systemic risks since they have region- or sector-wide implications, which make it challenging to deal with these risks through traditional pooling risk mechanisms. Anisa et al. (2022) emphasise that insufficient data collection and in-depth analysis frequently intensify the risk exposure, and it is necessary to establish efficient monitoring systems. Besides, Xie et al. (2024) propose that the risk exposure can be controlled through the advancement of public-private partnerships, and responsibilities among stakeholders can be distributed.

The importance of using agricultural insurance as a risk mitigation measure cannot be underemphasised. Agricultural insurance lessens the economic cost of crop failure, natural calamities, and pest attacks when the farmers have a safety net in place (Akinola, 2014). This will allow farmers to practice more resilient farming and invest in productivity-increasing technology without worrying about the potentially catastrophic losses (Baba et al., 2024). An example of this according to Panda (2021) is the stabilization of household incomes especially under rural settings where families are highly reliant on agriculture indicated by agricultural insurance. Moreover, Madaki et al. (2023) assert that agricultural insurance is associated with economic resilience on both micro and macro scales as it decreases the fiscal strain of the governments in connection to the extent of agricultural tout when mass processes occur. Skydan et al. (2023) suggest that agricultural insurance should become part of other risk management strategies not only to make food systems more resilient but also to work in the context of developing nations.

Agricultural insurance models are mainly of three models; indemnity-based, index-based, and hybrid models. Insurance founded on indemnity is based on measurement of actual losses that are incurred by farmers following occurrence of a negative event, and the assessment may be time-consuming, and it is also subject to moral hazard

(Gbigbi & Ndubuokwu, 2022). Index-based insurance, in contrast, involves the payment made on predetermined indices based on various factors like rainfall or temperature base as a quicker and clearer alternative (Niu et al., 2022). Hybrid models use the combination of both methods because the idea is to balance precision and efficiency (Ma et al., 2024). Vyas et al. (2021) consider index-based models as popular because of their scalability and low administrative costs. Nonetheless, there exist some issues, such as the basis risk, where it is quite possible that the index will not reflect the losses of the individual farmers (Ajemunigbohun & Abdul-Azeez, 2023). Reka et al. (2025) suggest that such technological advances, as satellite imagery and blockchain, may enhance these models in order to improve their outcomes.

Agricultural insurance has become one of the major strategies of reducing risks that arise in agricultural activities in Nigeria, a nation that largely depends on agricultural production especially as a source of economic improvement and food security. Despite its potential to stabilize farmers' incomes and encourage investment in the sector, agricultural insurance in Nigeria faces numerous challenges while simultaneously offering significant opportunities for growth.

Insurance in the agricultural sector in Nigeria has a history of many years back which started in the early 1980s where the Nigerian government had understood the importance of insuring farmers against the effects of natural disasters and fluctuations in the market. This evolution was significantly symbolized by the formation of the Nigeria Agricultural Insurance Corporation (NAIC) in 1987 that was aimed at giving farmers affordable insurance coverage (Nchuchuwe & Adejuwon, 2012). Agricultural insurance has over the years grown into the livestock behaviour, fisheries and agro-allied business ventures. However, the sector's development has been slow due to structural and operational challenges. Ehiogu and Chidiebere-Mark (2019) noted that, due to the absence of an adequate regulatory system and insufficient data on agriculture-related risk, the application of insurance schemes has not been very effective. Besides, Gavrilova (2021) notes that the current insurance environment in Nigeria is in the early stages of development relative to the international one, which is why new methods should be involved in closing the remaining gaps.

The NAIC is the main agent behind the advancement of agricultural insurance in Nigeria since it subsidizes premiums and organizes programs in risk management. According to Muhammad and Inusa (2024), the corporation has undertaken efforts that seek to enhance the level of penetration of insurance products amongst the smallholder farmers. Such efforts have consisted of cooperation with agricultural extension services and other financial institutions to stamp insurance as part of a larger rural development plan. Nonetheless, NAIC has not been effective due to its inefficiency of operation and funding. Bassey and Uwadima (2022) argue that the corporation's reliance on government subsidies has constrained its ability to scale operations independently. Moreover, Hellin et al. (2017) cite the fact that claim settlement in NAIC is usually delayed, which hurts the trust of insured farmers. Irrespective of these challenges, the NAIC continues to be a major pillar of Nigerian agricultural insurance sector, which can provide an invaluable experience in the future reformation process.

Synergy between insurers, banks, and agribusinesses is slowly gaining favor in involvement in the insurance of agriculture in developing countries. Olomu et al. (2020) stress that private businesses introduce new ideas and efficiency in the sphere since they are supported by technology, which allows improving the delivery of services. An example is the digitization of the premium payments and claims processing using digital platforms to make insurance more accessible to people in the rural areas. Nonetheless, there are major barriers to entry in the private sector such as high costs of transactions and infrastructure in the rural areas. As it is stated by Madaki et al. (2023), it is not always easy to make a compromise between profitability and affordability, especially when covering low-income farmers through private insurers. In order to resolve these problems, Owoade (2019) argues that there is a requirement of stronger pacts of public and private partnership to pool the risks and decrease the bottlenecks in operations. Partnerships of this nature can open up new vistas of large scale agricultural insurance in Nigeria.

2.1.1. Barriers to Agricultural Insurance Adoption in Nigeria

The adoption of agricultural insurance in Nigeria remains significantly low, despite its potential to mitigate risks and stabilize farmers' incomes. There are some obstacles that prevent a mass adoption of these insurance products such as social-economic aspects, as well as inefficiencies of the whole system of insurance. These difficulties can be summed into three main dimensions which include the issues of awareness and accessibility, affordability and premium structure, and trust and claim settlement. All these barriers are some of the reasons why agricultural

insurance has not penetrated the Nigerian farmer especially smallholder farmers who are the backbone of the agricultural sector in Nigeria.

Awareness and Accessibility Issues

The ignorance of farmers is one of the major hindrances to the acceptance of agricultural insurance in Nigeria. Most of the smallholder farmers lack knowledge on insurance products that are offered to them or lack comprehensive knowledge on the benefits of insurance policies. Chiedozie, Adebayo, and Ukwuaba (2020) postulate that educational campaigns and outreach programs are needed to overcome this gap of knowledge. The other key issue is accessibility whereby majority of the insurance companies are located in the city and hence the rural farmers have an unmet need..

Affordability and Premium Structure

Cost has been a big impediment to the adoption of agricultural insurance and particularly in case of resource-poor farmers. According to Akinola (2014), the cost of insurance policies discourages most farmers against taking up policies due to premium rates. Although subsidies provided by the government and other organizations such as NAIC are effective to mitigate this problem, they usually cannot address the demand of all farmers. Gavrilova (2021) recommends creating the structures of flexible premiums that should be adjusted to the various income levels making insurance less expensive. New arrangements in financing that have the potential to facilitate cost-reduction and coverage expansion include index-based insurance.

Trust and Claim Settlement Concerns

Another major issue is trust to agricultural insurance providers. Farmers have also raised concerns on the effectiveness of the settlements of the claim citing delays and bureaucracies. Hellin, Hansen, and Arabab (2017) indicate that the confidence in insurance products is hurt by the perceived inefficiencies in the claims process. According to Bassey and Uwadinma (2022), the revival of trust should be achieved through transparent and timely mechanisms of claim settlement. Also, Muhammad and Inusa (2024) emphasize the necessity of informing farmers about their rights and entitlements under the insurance policies, which also may make them trust the system more.

2.1.2. Extreme Weather Events and Climate Variability in Nigeria

Climate variability and extreme weather events have become characteristic problems facing Nigeria, especially because of their wide-spread effects on environment, economy, and the society. Understanding these events is directly relevant to agricultural insurance because their frequency, intensity, and spatial distribution determine claim volumes, premium structures, and the long-term solvency of insurance providers. Such events are not only the results of the global climate change but are symptoms of the regional vulnerability caused by socio-economic factors and environmental ones (Intergovernmental Panel on Climate Change, 2021a). At the ecosystem, livelihood and food systems level, in Nigeria, the combination of extreme weather conditions (flooding, drought, heatwaves and pest epidemics) and more general climatic variability has caused disruption. These challenges are further complicating because of the diversity of the geographical territory of the country, which starts with the arid Sahel in the north and the tropical rainforests in the south (Abiola et al., 2022). Consequently, getting to a better comprehension of the nature, causes and impacts of extreme weather event and climate variability has been essential in ever coming up with adaptive measures needed to counter their negative impacts.

Extreme weather events refer to aberrant, rare, or out of season meteorological occurrences that collide considerably with the regular climatic temperatures of a region (Intergovernmental Panel on Climate Change, 2021b). Such events could be divided into hydrometeorological extremes such as floods, droughts, etc. and thermally driven ones like heatwaves, cold spells (Modilim, 2025). Climate variability has caused more intense and frequent extreme weather events in Nigeria, given that the occurrence of such an event is not only prompted by natural forces but is also enhanced by human activities (Baba et al., 2024). Classification of these events usually involves distinction based on their duration, severity and the effects they have on human and ecological systems. As an example, floods are classified according to their frequency period, and the indices to measure droughts include the Standardized Precipitation Index (SPI) (Wang et al., 2022). Knowledge of these classifications is essential in coming up with adaptive measures in reducing the negative consequences of a disaster in form of extreme weather events among the vulnerable groups of people and areas of economic activity, especially agriculture.

Patterns of Climate Variability in Nigeria (2000–2025)

Nigeria has undergone considerable climate changes in the last 20 years, in the form of an increase in rainfall alteration, warmer conditions, and longer dry seasons, drawn from the Nigerian Meteorological Agency (NiMet) historical datasets, UNDP national climate reports, satellite-based reanalysis products (ERA5) (United Nations Development Programme, 2022). Lack of a stable pattern of rainfall has characterized the country in the last 2 decades, with flooding in some areas due to excesses as opposed to droughts in other sections brought on by long dry periods (Abiola et al., 2022). Temperature records show that it is gradually raising, and there are larger and more heatwaves in the northern regions of the nation in particular (Oluwatimilehin & Ayanlade, 2023). These are growing tendencies that correspond with the projections of climate change concerning the universe, indicating that sub-Saharan Africa, comprising Nigeria, will be hit excessively by the climate change (Intergovernmental Panel on Climate Change, 2021b). Researchers such as Mbonu (2025) opine that such trends are further exacerbated by the likes of deforestation, urbanization and unsustainable agricultural activities which exert further

Major Extreme Weather Events Affecting Agriculture

Since agriculture happens to be the activity that provides the majority of Nigerians with its employment (70% of the population), it is extremely vulnerable to abnormal weather conditions and climate fluctuations (United Nations Development Programme, 2021). Floods, droughts, heatwaves, and pest outbreaks affect the sector and mean that crops do not yield well, the soil loses fertility, and food security is at risk (Baba et al., 2024). Smallholder farmers are especially vulnerable to these events since they are mostly rain-fed and cannot afford adaptive technologies or have access to funds to overcome climate shocks. As an example, floods lead to destruction of arable land and the displacement of the rural populations, and droughts increase water shortage and decrease crop production. Heatwaves, in turn, negatively affect the physiology of crops, and outbreaks of pests add to the damage by infecting already weakened crops (Lesk et al., 2022). All these cases of extreme weather conditions underscore the pressing necessity of measures to develop resilience in the agricultural sector of Nigeria.

a. Floods and Their Economic Impact on Smallholder Farmers

Flooding is one of the most catastrophic weather extremes in Nigeria when it comes to the agricultural sector, especially smallholder farmers who majorly practice rain-fed agricultural production (Ortiz-Bobea, 2021). Since 2000, there have been horrific flooding disasters in some states in Nigeria, such as Kogi, Niger and Anambra, which caused mass destruction of crops and livelihoods (Prince, Obiorah, & Ogar, 2023). The Institute for Peace and Conflict Resolution (2021) states that floods not only kill farmlands but also break food supply chains, which leads to increases in the prices of commodities making it hard to tackle food insecurity. This is a tremendous economic loss as it is estimated that losses caused by floods in agriculture were up to over 1 billion dollars in peak years of flooding (Habib-ur-Rahman et al., 2022). Measures put in place to offset such effects comprise drainage networks and early warning systems, but there are still difficulties in scaling up the initiatives to the rural regions (Lobell et al., 2011a).

b. Droughts and Water Scarcity in Agricultural Production

The other major threat to agricultural productivity in Nigeria is the occurrence of droughts, mostly in the semi-arid zones of the north (Gaur & Verma, 2023). The water shortages have also occurred as a result of prolonged dry spells which has affected the availability of irrigation water lowering the yields of crops (Schlenker & Roberts, 2009). Lesk et al. (2022) conduct research that makes it clear that the production of maize, sorghum, and millet has dropped by up to 30% in the drought seasons in the north of Nigeria. This reduction is blamed on low moisture content of soils and high rates of evapotranspiration due to the increase in temperatures (Malhi, Kaur, & Kaushik, 2021). In an attempt to cope up with these issues, some have come up to innovate, like coming up with drought resistant crop varieties and water saving practices (Emmanuel et al., 2024). Nevertheless, there are still hindrances related to the availability of resources and underdeveloped policy implementation (Tonnang et al., 2022).

c. Heatwaves and Crop Yield Decline

Heatwaves have become one of the most significant issues of Nigerian agriculture, and an increase in temperatures negatively affects the crop physiology and potential yields (Zhou & Vilar-Zanon, 2025). Research points to the fact that heat stress lowers photosynthetic efficiency, hastens maturity, and lowers grain quality (Rezaei et al., 2023). As a case in point, rice and wheat agriculture in Nigeria has recorded large declines in productivity whenever there are prolonged hot temperatures (Bhardwaj et al., 2022). According to an estimate made by Lobell et al. (2008), every 1OC

above-optimal temperatures results in a 10 per cent decrease in cereal production. Measures to adapt to such effects have been offered in the form of crop planting date changes and the use of heat-tolerant crop varieties (Singh, Jyoti, & Sankaranarayanan, 2024). However, the success of these measures relates to farmer awareness and support by the institution (Grigorieva, Livenets, & Stelmakh, 2023).

d. Pest Outbreaks and Agricultural Losses

The trend in climate variability has also led to outbreaks of more pests thereby increasing risks to agricultural practices in Nigeria (Panda, 2021). Increasing temperatures and changes in rainstorms patterns present favourable conditions that encourage the living of farm pests like locusts and armyworms as well as stem borers, which destroy crops and lower harvests (Ma et al., 2024). Wambua and Okeke (2023) found that Nigeria was affected by pest infestations that caused about 20% of annual agricultural losses in the period between 2020 and 2023. Most particularly, smallholder farmers that have no access to pesticides and integrated control of pests have been seen to be at risk (Osuji, Olaolu, & Tim-Ashama, 2023). The only solution to this problem is to work at the national and regional scope by making investments to research and extension activities to foster sustainable ways of pest control (Sun et al., 2024). According to Bhushan et al. (2016), they mention that utilization of technology, including remote sensing and predictive modeling have become crucial when it comes to monitoring and managing pest outbreaks. Extreme weather events and climate variability present formidable challenges to Nigeria's agricultural sector, threatening food security and livelihoods. Although different adaptation measures have been suggested, they depend on sound policy structures, sufficient investments, and engagement of locals (Schuurman & Ker, 2025).

2.1.3. Financial Implications of Climate Risks on Agricultural Insurance

Risks associated with climate change related to agriculture insurance are especially felt financially through the heavy or dramatic occurrence of weather extremities that are occurring frequently and becoming even worse. Climate change has presented completely new challenges not only to farmers but also to insurers to change the way risk is managed in the agricultural sector. The increasing temperatures, unpredictable rainfall and frequency, and the calamitous phenomena of floods and droughts have not merely interrupted the agricultural output, but they have also made the finances of the insurance mechanisms opted to cover such risks unviable (Intergovernmental Panel on Climate Change, 2021a). The agricultural insurance is very essential in reducing the detrimental effects of climate change by acting as a cushion to farmers who experience unforeseen losses. But with the increase in climate risks, these insurance mechanisms are being challenged in terms of financial feasibility. Lobell et al. (2011b) argue that because of the rising incidence of variability in crop production as a result of climate-related causes, there have been increasing frequencies and payouts of claims, all of which put immense pressure on insurers. Moreover, Elahiet et al. (2022) point out that the high cost of extreme weather to farmers is another factor behind their need to access inexpensive insurance products because they need affordability, or such offerings are less profitable to insurers. The vulnerability of agricultural system to climate risks has also led to the changing trends in insurance claims. The authors refer to Sun et al. (2024) to note that with raising climate risks, the world is observing an increase in indemnities being paid out by insurance companies, which means that more complex risk modeling approaches are required to be devised to more appropriately estimate and control such exposures. Simultaneously, the insolvency of insurance providers will be dangerous, and according to Reka et al. (2025), it is possible that poor reserves and increased reinsurance pricing will threaten the sustainability of agricultural insurance markets in the long run. These issues need to be solved by innovating new means such as technological innovations to eliminate such processes, regulation changes, and public-private collaborations to bring agricultural insurance back to be a viable method that can be used to mitigate climate risks in the future. To illustrate with concrete financial indicators: global insured losses from natural catastrophes exceeded USD 125 billion in 2022 (Swiss Re, 2023); in Nigeria specifically, NAIC reported that post-flood claims in 2022 surpassed the corporation's annual risk capital by 30% (NAIC, 2023), while the combined loss ratio for agricultural lines in Nigeria averaged above 110% during 2020–2022, indicating that insurers paid out more in claims than they collected in premiums. These metrics underscore the acute solvency pressure that climate-driven claims place on agricultural insurance providers.

2.1.4. Impact of Climate Risks on Agricultural Production and Yield Stability

Climate risks have notable effects towards agricultural production and stability of yields such as droughts, floods, heat waves and irregular rainfall patterns. These risks are becoming more aggravated by climate change which makes innate farming techniques unstable and also, endangers food security (Intergovernmental Panel on Climate

Change, 2021b). As an example, Lobell et al. (2011a) point out that increased temperatures and shifts in precipitation negatively affect yields in most of the regions, especially in sub-Saharan Africa and in South Asia. On the same note, Lesk et al. (2022) show that extreme weather has contributed to large losses of major staple crops such as maize and wheat, which have further disrupted agricultural production. The economic effects of such interruptions are enormous with decreased yields converting to losses in income earned by farmers and high price fluctuation in the food markets (Malhi, Kaur, & Kaushik, 2021). The unpredictability of weather patterns in Nigeria has subjected smallholder farmers to expensive responses to impede its pressuring effects, as Abiola, Olaniyan, and Fadun (2022) highlight that farmers have had to use the more expensive option of changing to drought resistant crops or to invest in irrigation systems to adapt to its effects. This instability further makes marketing of agricultural insurance a problem whereby, according to Akinola (2014), there is a direct relationship between the magnitude of the variation in the yields and the increase of claims. Moreover, works by Gbigbi and Ndubuokwu (2022) highlight the long-term damage to the productivity brought about by chronic exposure to climate risks and therefore the need to develop new types of risk management.

2.1.5. Economic Burden of Extreme Weather Events on Farmers

Extreme weather incidences are a very big burden to farmers a few of them are even driven at the edge of bankruptcy. Bhushan et al. (2016) report on the extensive destruction of agricultural land due to flooding in India, which lost its means of subsistence of thousands of farmers. Equally, Emmanuel et al. (2024) state that due to frequent droughts in the East African region, most households have been plunged into poverty to the extent of having to sell their assets or relocate to find alternative sources of income. This vulnerability is compounded by inability to access cheap insurance in developing countries. According to Ajemunigbohun and Abdul-Azeez (2023), uninsured losses caused by occurrence of extreme weather events further increases the financial burden of the farmers to meet cost of recovery. Baba, Abdullahi and Garba (2024) identify in their study in Nigeria that farmers tend to use informal credit schemes in disaster recovery stabilization leading to debt cycles. On a global level, Panda (2021) points to the lack of reliable insurance systems that would allow unprotected farmers to face devastating losses and urges scalable solutions. Also, what Myslimi, Nikolli, and Shima (2022) emphasize is that the challenge of this issue should also be resolved with more and better insurance products in addition to better education on risk mitigation measures.

2.1.6. Climate Risk Exposure and Insurance Claim Trends

Due to the high number of climate risks, there are rising trends in the agricultural insurance claims. Research indicates that the frequency of bad weather has been on the increasing trend with the result being that insurance companies are experiencing a rising trend in payout. This trend was first identified by Smith and Glauber (2012) who provided evidence that an increase in temperatures and change in rain patterns had already started increasing claim volumes in the United States. Similar conclusions can be achieved through more recent studies by Sun et al. (2024) who indicated that the global warming situation has hardly improved indemnity payments in various areas of concern. Niu, Yi and Chen (2022) offer empirical evidence that associates particular climatic variables, including temperature anomalies and deficits of rainfall to surges in insurance claims. Their contribution corresponds with those of Zeng et al. (2022), who concluded that an extended period without any precipitation in China resulted in unprecedented compensation claims by insured agriculturalists. In the meantime, the authors cover how advanced technologies, i.e., satellite imagery and machine learning algorithms, could be used by insurers to measure the exposure to climate risk by modifying premiums in accordance (Anisa et al, 2022). Nevertheless, even with such advances, Madaki et al. (2023) warn that limited or flawed data collection still presents a challenge to proper risk modeling, especially in the low-income world where not much is recorded in the past.

2.1.7. Solvency Challenges for Agricultural Insurance Providers

The growing financial cost of catastrophes risks make agricultural insurance providers face big solvency problems. Claim volumes are also increasing thereby creating pressure on insurers to ensure that they maintain a sufficient reserves without necessarily increasing premiums paid by farmers. According to Reka et al. (2025), unless action is taken proactively, the majority of insurers will not be able to stay afloat in the conditions of aggravated climate consequences. In India, Bhardwaj et al. (2022) estimate the impact of the high frequency of payment after several seasons of poor crop results in reducing capital resources, which causes some corporations to leave high-risk regions completely. The Skydan et al. (2023) suggest that reinsurance partnerships may provide one possible means of solution with the capability of transferring the overflow of the risk to larger entities that are more able to absorb the

losses. Yet, Vyas et al. (2021) note that even the prices of reinsurance are also increasing, thereby bringing more financial setbacks to smaller companies. Besides, Ma et al. (2024) emphasize the need to diversify portfolios in order to avoid concentration risks with localized tragedies. At the policy level, Nshakira-Rukundo et al. (2021) promote government subsidies and partnerships between governments and insurance companies with the aim to enhance the resilience of insurers. Last, Xie et al. (2024) emphasize that regulatory frameworks ensure transparency and accountability in the industry, which therefore protects both the insurers and policyholders against future shocks.

2.2. Theoretical Framework

Agricultural insurance in vulnerable regions of the world is a thorny problem of risk management that lies at the crossroads of individual decision-making, market design and systemic financial stability. As such, the study aim to rigorously analyze this intersection and propose an integrated theoretical framework, at the micro level, combining behavioral theory, at the meso level, combining insurance market theory, and at the macro level, combining financial stability concepts..

At the individual level, the decision about purchasing agricultural insurance is essentially a choice under uncertainty. Expected Utility Theory (von Neumann & Morgenstern, 1944) is the canonical theory: with risk-averse, agent's utility of insurance equals expected utility of outcomes with and without insurance, given the agent's subjective judgment of probability of loss. However, in low-income agrarian settings, this calculus is complicated by a lack of experience with formal financial products, cognitive constraints in processing probabilistic climate information, and liquidity constraints that make premiums unaffordable even with perceived risk at a high level. For the uneven adoption of insurance despite objective exposure, the study adopts Rogers' Diffusion of Innovations Theory (2003). Insurance serves as a technological innovation that is dependent not only on economic rationality, but also on the process of social learning, network effect and perceived compatibility with local farming practices. Attributes like observability (e.g. seeing neighbours benefit from payouts) and trialability (e.g. participation through cooperatives), critically shape trajectories of diffusion. This behavioural-institutional lens is useful for explaining persistent coverage gaps in emerging markets, where not just insurance but insurance products are not merely under-priced or unavailable-but are socially and cognitively distant.

At the market level, agricultural insurance faces two canonical problems in insurance economics namely adverse selection and moral hazard (Akerlof, 1970; Pauly, 1968). Adverse selection occurs when farmers with greater unobserved risk exposure are more inclined to join the program, such that the pool of risks getting government payments appears to be skewed, leading to higher premiums. Moral hazard can occur, for example, when insured farmers make fewer investments in risk-mitigating procedures, expecting to be indemnified. Both problems are intensified by climate change as non-stationarity in weather patterns is their undoing for the reliability of past data hence prices for risk classification. Compounding these information frictions is the solvency constraint that is inherent in insurance operations. Solvency theory focuses on insurers having adequate capital to meet obligations under stress circumstances, especially the kind of correlated losses. Climate-induced extremes events - by their spatial and temporal clustering - present exactly the type of non-diversifiable risk that threatens capital adequacy. In markets where reinsurance capacity is shallow and the access to risk transfer mechanisms at global levels is limited, insurance companies face a trade-off between inclusivity (affordable premium for low-income farmers) and resilience (sufficient reserves). This tension emphasises the importance of alternative risk-transfer designs such as index-based insurance, which attempts to address the issue of moral hazard as well as administrative costs by binding insurance payouts on weather indices which can be objectively measured, rather than on self-reported losses.

At the systemic level, the concentration of climate-driven insurance losses may have ripple effects beyond individual financial institutions to impact financial system stability more generally - an approach increasingly highlighted in the literature on climate-related financial risk (Bolton et al., 2020; Financial Stability Board, 2020). While agricultural insurance is certainly seen as a niche market, failure could have a second-order impact: uninsured farmers default on agricultural loans, uninsured farmers default on agricultural loans, disrupting rural credit markets; repeated insurer insolvencies, creating pressure on governments to act as insurers of last resort and/or reduce confidence in formal risk transfer mechanisms; and pressure on governments from fiscal instability as governments become insurers of last resort. This macro-financial lens changes the perspective on agricultural insurance from that of a micro risk transfer instrument into a node in a much larger climate-fiscal-financial network of interdependencies. In emerging economies where agriculture still remains a pillar of economic activity and employment, therefore the solvency of the agricultural insurances becomes a matter of macroprudential concern. Regulatory frameworks must

therefore take into account not only firm-level capital requirements, but also the systemic consequences of correlated climatic shocks across sectors and regions.

By creating synthesis of these three layers, the study's framework promotes a view of agricultural insurance in climate-stressed environments. It bridges the micro-foundations of insurance demand with the meso-dynamics of market design and the macro-realities of the resilience of the financial system. Crucially, it shows feedback mechanisms: low adoption (micro) fuels insurer risk concentration (meso), which fuels systemic vulnerability (macro). Conversely, strong public-private risk pools or parametric products could simultaneously tackle improvement in access, more accurate pricing and lower systemic exposure.

This integrated perspective goes beyond traditional insurance theory by placing it within a context of climate risk where non-stationarity, information gaps and institutional constraints redefine the limits of insurability. It therefore adds to current scholarly and policy debates on how insurance markets can be made viable, inclusive, and resilient in a time of accelerated environmental change.

2.3. Empirical Review

In the study titled the impact of extreme climate events on financial performance: evidence from manufacturing firms in Europe by Denna (2024), the researcher examines the profound effects of climate change on global economies, with a specific focus on the financial performance of manufacturing firms in Europe. It also points at human action, such as fossil fuel burning, cutting down of forests, and commercial operations, which have contributed hugely to the emission of greenhouse gases hence the resulting climatic changes and warm temperatures worldwide. Citing concerns on the IPCC report, the study places significant precedence on rapid response efforts in curbing climate change and that failure to reduce the global average by 1.5 degrees above the pre-industrial level can cause an irreparable damage on both natural and human systems by 2030. It is indicated that the research focuses on the increasing intensity and frequency of the occurrence of extreme weather events, including heat waves, floods, and storms and how they are affecting industries (especially the manufacturing ones). These climate-related challenges have been revealed to make European manufacturing firms susceptible to damage in the chain of supply of materials, energy availability, and susceptibility in production.

In the study titled climate change impacts on the insurance industry by Camazzola (2023), the researcher investigates the qualitative and quantitative effects of climate change on the insurance sector, focusing on both transition risks and physical risks. The nature of transition risks is the transition towards a Net Zero Emissions scenario, a transition that places pressure on companies dependent on nonrenewable sources of energy to rapidly change. Physical risks, in turn, are caused by the shrinking span and intensities in weather-related events resulting in rampant destruction, business-stalling, as well as a substantial loss to homeowners and companies. These risks, as seen in the eyes of insurance companies, come in the form of greater number of claims and coverage demand.

In the study titled 'analysis of the relationship between extreme weather disasters and claim ratio volatility under global climate change' by Li and Pu (2024), the researchers examine the connection between extreme weather events and property insurance claim ratios, emphasizing the critical link between extreme weather risk–catastrophic loss–high claim ratio–insurer solvency. Although it is agreeable that effects of extreme weather are immense on life and property, little research has been conducted to investigate the processes between these aspects. During 2012-2021, the study uses a dataset consisting of 30 provinces in China and compiles indices of high temperature, low temperature, and heavy precipitation in order to determine their relationship with claim ratios. The results show a significant connection between extreme events of weather and the ratios of claims and that the indices have a large effect in increasing ratios by 3- and 5-year scales. The rise in claim ratios partially or completely mediates solvency in the insurance property firms reflecting the weakness of insurers against climate-related risks.

In the study titled climate risks and financial stability: evidence from the European financial system by Chabot and Bertrand (2023), the authors address the growing concern of climate-related risks as a significant threat to financial stability, particularly within the European financial system. The paper commences presenting a theoretical framework to understand how both physical and transition risks are transmitted to financial institutions and financial system. Based on bank-level and system-wide indicators of financial stability the authors evaluate their influence using the factor of Scope 3 greenhouse gas emissions and chronic climate risks like rising temperatures as well as acute climate risks such as heatwaves, wildfires, and droughts. Their results indicate that these climate risks

are adversely influencing financial stability at both the level of individual financial institutions, and at the level of the system. One should also mention such threats as temperature anomalies, heatwaves, wildfires, and droughts.

In the study titled the impact of natural disasters on the performance and solvency of US banks by Xu (2020), the researcher investigates how large-scale natural disasters influence the profitability and solvency of banks in the United States. The study using a sample of 187 natural disasters that have occurred within the period 2000-2014 and data of 2,891 banks revealed that natural disasters have significant impacts on such key financial measures as net-income-to-assets ratio, net-income-to-equity ratio, impaired loans, and return on average assets. The analysis also reveals considerable effects to such solvency related ratios as the equity ratio and the tier-1 capital ratio. Interestingly, the effects on solvency vary depending on the geographic scope of the banks' operations. Regional banks have positive changes in their levels of capital reserves, choosing to augment this during the instances of disasters in areas of their operations. Against the backdrop, banks with local and national districts of activity on the territory of the country face quite adverse changes in their solvency indicators indicating a higher probability of suffering in the face of the financial disturbance caused by natural disaster.

In the study titled examining the impact of climate change on insurance risk and pricing in Nigeria by Modilim (2025), the researcher investigates how climate change influences insurance risk modeling and pricing strategies within Nigeria's insurance industry. Realizing climate change as one of the critical challenges in the present century, the report points out the widespread impacts of climate change on priority sectors of the Nigerian economy such as agriculture, health, and infrastructure. Through surveys and statistical analysis of the industry, the study examines how Nigerian insurers have incorporated projections of climate change in the risk estimation and valuation schemes used in the enterprise. The paper determines that the three major issues presented by climate change are physical risks due to extreme weather-related events (e.g., floods, storms, heatwaves, and droughts), transition risks due to the move towards a low-carbon economy, and liability risks through third-party compensation claims. In correlation analysis, it is indicated that the physical risk brings a moderate positive output on frequency and severity of insurance claims, meaning that insurers will have to amend their models to take into consideration the rising number of extreme weather conditions. Liability risks, in turn, are less correlated, which implies that they are less relevant to influencing the overall claims developments.

In the report titled, 'the implications of climate change for financial stability by Board' (2020), the potential impacts of climate change on financial stability are explored, focusing on the channels through which climate-related risks may affect the financial system. The report differentiates physical risk, which is caused by the actual or projected economic impacts of the ongoing climate change, and transition risk, which is necessitated by changes toward a low carbon economy. The report builds on existing work in the official and private sectors and points out that existing central estimates of physical risks to asset prices are broadly contained though they have been exposed to large tails. The physical manifestation of risks may be greatly increased in the financial system instability and manifested even over the short-liability through self-aggravating acceleration in climate change. The concentration of these risks in certain sectors, geographies and/or in emerging market and developing economies (EMDEs) with weaker risk-sharing arrangements, can make vulnerabilities particularly acute. Equally, an abrupt transition away to a low-carbon economy driven by sudden policy or technology shocks, or, the realization of physical risks can trigger a chaotic, non-linear dynamic – characterised by sudden shifts in investor sentiment, abrupt asset repricing, and contagion across interconnected financial markets – in the financial markets

Climate-related risks also have the potential to alter the global financial system's response to shocks, leading to abrupt increases in risk premium, changes in asset price correlations, and amplified credit, liquidity, and counterparty risks. Such dynamics may undermine existing risk diversification and risk control practices, weaken resilience in the financial system and induce bank lending and insurance supply contractions. The report notes that the scope and scale of climate-related risks can lead to their impact being more insidious than other economic risks, especially through interaction with greater vulnerabilities in the macro economy as a whole, and imposes significant challenges to financial stability.

3. Method

The area for this study is Lagos State. It is situated in the south-western corridor of Nigeria and is one of the economically and socially valuable localities. Its geographical position on the Atlantic coast, coupled with its status as the nation's commercial hub, shapes its climatic conditions, demographic trends, and the nature of its industries. The state's vulnerability to coastal flooding and its role as a key agricultural area underscore the importance of understanding these interconnected factors. Lagos State was purposively selected for three reasons: (1) it is home to the highest concentration of licensed agricultural insurance companies in Nigeria, making it uniquely suited for studying insurer-side dynamics; (2) its peri-urban and coastal smallholder farming communities experience a diverse range of extreme weather events including flooding, storms, and erratic rainfall, providing rich variation for risk-exposure analysis; and (3) Lagos accounts for a disproportionate share of Nigeria's agricultural insurance premium income, making findings particularly policy-relevant at the national level.

The climate of Lagos is tropical with high atmospheric temperatures and moisture all year round. Temperatures vary between 25 and 32 C (77 and 90 F), and peak during November through to March. As the hottest month, March has an average temperature of 33o C (91o F), whereas, in the coolest month, August, average low temperature is 24o C (75o F). There are consistently high humidity levels with an average of 83 per cent. This humidity is highest in June reaching 87 and the lowest in March 76. The year is well separated in rainy and dry seasons. Monsoon season is normally between April to October, which receives a lot of rain, especially during April and July. On the other hand, the dry season is between November and March, which may be also, accompanied by dry and dusty winds the harmattan coming out of the Sahara.

As Nigeria's foremost commercial center, Lagos is the heart of the country's insurance industry. A big number of the 57 insurance companies plus two reinsurance companies registered in Nigeria have their headquarters in the city. The insurance market in Lagos provides a wide circle of clients ranging between individuals, firms and government; the role of the brokers in this market cannot be ignored because they collect more than 90% of the premium incomes. The sector is currently undergoing a significant transformation, driven by the National Insurance Commission's (NAICOM) mandate for increased capital requirements. The hope is that this recapitalisation will enhance the financial strength of the insurance firms and develop more confidence among the populace.

The study population includes the agricultural insurance firms and smallholder farmers in Nigeria. Agricultural insurance providers, including the Nigeria Agricultural Insurance Corporation (NAIC) and private-sector insurers, represent a critical segment of the study, as they bear the financial risks associated with extreme weather-induced claims. Smallholder farmers who are either insured or not are another major component of the population since they directly suffer the agricultural losses caused by climate variability. The choice of these two groups is explained by the fact that they are the most exposed to the financial risks of climate changes and play a key role in the exploration of the insurance solvency subject in the agricultural sphere (World Bank, 2022). LagosAgric estimated that there are 100,000 people comprising the smallholder farmers' population. Although the target population is defined at the national level, data collection was restricted to Lagos State as a purposive case study site. This is justified on methodological grounds: Lagos concentrates the majority of agricultural insurance firms and their operational data, enabling a matched study of both insurer and farmer perspectives in one geographical unit. This approach follows the embedded case study design (Yin, 2018), where a nationally significant case is studied in depth to generate transferable insights rather than statistically generalisable estimates. Readers should therefore interpret the farmer-level findings as representative of peri-urban Lagos smallholders, while the insurer-level findings have broader national relevance given the firms' nationwide portfolios.

To select the respondents of the study, a multi-stage sampling method was applicable. In the case of smallholder farmers, it concentrated on smallholder farmers involved in mixed farming where crops and livestock production are involved. Mixed farming is the one that is especially applicable to Lagos State in which it is prevalent and directly affects the changes in claims and adaptation mentioned to climate variability. Stratified random sampling was used to obtain the required diversity within this group. The young people in rural areas, who are smallholders, were selected in rural areas.

Two agricultural zones or areas were randomly sampled out of the three agricultural zones in Lagos State. Each of the two agricultural zones was represented by 3 LGAs randomly chosen equating to a total number of 6 LGAs. Within each of the 6 LGAs, two communities were randomly selected giving a total of 12 communities. This study

was done in 12 communities where five crop farmers, five livestock farmers, and five farmers in the mixed farming arrangement were randomly sampled to provide a total of 180 respondents to the study

In the case of Insurance firms, they form an imperative in the context of determining the institutional views on risk management, solvency and claims processing. But theirs is low in number as opposed to farmers. In selecting the insurance companies purposive sampling was adopted to sample only those companies dealing with only General Insurance Business Underwriting and those with their head office in Lagos State.

Number of General insurance companies in Nigeria = 29 (NAICOM, 2025). The study used 15% proportionate sampling technique with each company having at least one stratum or in other words, 4.35. Consequently, 4 insurance firms conducting general insurance business were, thus, chosen. Moreover, Ten (10) copies of the questionnaire was handed out to every one of the sampled insurance firms and the questionnaire was specifically distributed to Four (4) top management and Six (6) middle management employees, totalling in Forty (40) questionnaires. The chosen companies were: The 15% proportionate sampling rate is grounded in the purposive and institutional nature of the insurer sub-sample: given the small finite population (N=29 firms), a Yamane (1967) formula at 95% confidence and 5% margin of error yields a minimum sample of approximately 27 firms – not feasible for an in-depth institutional study. For small institutional populations, Cochran (1977) recommends census or near-census sampling where N is under 30; however, given access constraints, 15% (n=4) was adopted to achieve at least one representative stratum per firm type, ensuring structural diversity rather than statistical representativeness.

Table 1. Sample Size

S/N	Name of Company	Authorized Business	RIC	Sample Size
1	Custodian & Allied Insurance Limited	General	010	10
2	Linkage Assurance Plc.	General	026	10
3	Mutual Benefits Assurance Plc.	General	027	10
4	Nigerian Agricultural Insurance Corporation (NAIC)	General	030	10
Total				40

The companies were selected due to their prominence and diverse offerings in agricultural insurance within the private sector. These companies *collectively* offer a wide range of relevant products, including crop insurance, livestock insurance, weather-index insurance, farm asset insurance, agribusiness liability insurance, agricultural equipment insurance, crop failure insurance, livestock mortality insurance, and farm income protection insurance. This diverse product portfolio indicates their significant involvement and expertise in addressing various facets of agricultural risk.

This study relied on both primary and secondary data sources. The questionnaire contained open-ended and close-ended questions. Some of the questions were structured on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) to facilitate quantitative analysis. The questionnaire covered key areas such as demographic information, climate variability, insurance risk exposure, financial losses, and mitigation strategies. The study used a structured questionnaire as the primary data collection instrument. Questionnaires and interview schedule were administered in-person, ensuring broad coverage and higher response rates and also. The questionnaire was divided into two key sections:

Section A: This section was based on the Demographic Information of the respondents, and it included the following: Age, farming experience, location, and insurance status.

Section B: This section included questions related to each of the objectives of the study.

Data for the study were analysed using descriptive statistics like frequency, mean, and percentages, as well as inferential statistics.

Objective I, and III were analysed using descriptive statistics such as frequency, mean and percentages. While *objective II*: Examine the Level of Risk Exposure of Crop Farmers to Climate-Induced Disasters. Risk exposure assessment employed the use of structured categorization of data based on five-point Likert data of perceptions by farmers on the dangers of exposure to various climatic risks. The risk categorization framework assigned the levels of exposure to different classes or levels namely, low (1.00-2.33), medium (2.34-3.66), and high (3.67-5.00), which facilitated the interpretation of possible levels of vulnerability of the farmers in line with the various risk aspects. The results were descriptive statistics such as means, standard deviations, minimum and maximum values of five risk categories i.e. risks due to flooding, risks due to droughts, risks due to heat waves, risks due to post-event pest outbreaks, and risks due to market fluctuations after the event.

Objective IV: Examine Accessibility and Uptake of Agricultural Insurance. Insurance uptake analysis included cross-tabulation and percentage analysis to reveal trends in the growth of agricultural insurance uptake according to the characteristics of the farmers, and it indicated the forces and conditions related to the high or low rates of insurance adoption. The way of analysis is full cross-tabulation of the choice of insurance according to the main demographic and operational peculiarities, such as gender, education level, farming experiences, and main type of crops, and the status of cooperative membership. Each category was calculated in terms of purchase rates and the overall uptake rates were established to aid in defining the levels of baseline adoption of the given farming community.

Objective VI: Ascertain the Volume of Claims Due to Agricultural Risks (2020-2024). Time-series descriptive analysis was applied in this claims volume analysis of agricultural insurance claims over the five-year period with distinction between climate-based and other agricultural risks in order to provide specific insights into the evolving burden on the insurance providers. To have a closer look on the volume of risks covered in this program, annual descriptive statistics were performed on the sum and the frequency of claims portrayed by type of risks to be able to detail the interpretation of how each type of agricultural risks was reflected in the insurance payment. The analysis also presented an exhaustive trend analysis of the changes in claim volumes between 2020 and 2024 stating maximum claims per category and per year in an attempt to identify extreme claim events that caused some unprecedented challenges to the insurance providers.

Objective VII: Assess Financial Impact of Claims on Insurance Firm Solvency. The Solvency impact assessment is a simple linear regression analysis that was used to determine the correlation between financial impact of claims and firm solvency, which offers statistical substantiality of data that depicts the relationship between financial implications of claims as well the financial stability of insurance firms.

Model Specification for Hypothesis 1:

$$\text{Solvency} = \beta_0 + \beta_1 (\text{Claims}) + \varepsilon$$

Variables:

Solvency (Y): Financial solvency of agricultural insurance firms

Claims (X1): Total claims paid due to agricultural risks

β_0 : Intercept

β_1 : Coefficient representing change in solvency per unit change in claims

ε : Error term

To ensure data quality, the questionnaire was validated and tested for reliability before full-scale deployment. Content validity was assessed, and the questionnaire underwent expert review by insurance specialists and climate risk analysts to confirm its relevance and clarity, while Reliability was tested using Cronbach's Alpha coefficient. A Cronbach's Alpha of above 0.7 indicated reached for all dimensions translating to an acceptable internal consistency (Nunnally & Bernstein, 1994).

4. Results and Discussion

RESEARCH QUESTION ONE: What are the socio-demographic characteristics of the crop farmers and the demographic characteristics of the insurance firms?

Table 2. Socio-Demographic Characteristics of Farmers

Socio-Demographics	Category	Frequency	Percentage	Mean
Age	18-30 years	32	17.8%	45.2 years
	31-40 years	39	21.7%	
	41-50 years	41	22.8%	
	51-60 years	42	23.3%	
	61+ years	26	14.4%	
Gender	Male	83	46.1%	
	Female	97	53.9%	
Education Level	No Formal Education	33	18.3%	
	Primary	65	36.1%	
	Secondary	53	29.4%	
	Tertiary	29	16.1%	
Farming Experience	1-5 years	41	22.8%	12.8 years
	6-10 years	51	28.3%	
	11-20 years	53	29.4%	
	Over 20 years	35	19.4%	
Main Crop Cultivated	Cassava	38	21.1%	
	Maize	54	30.0%	
	Vegetables	49	27.2%	
	Others (yam, plantain, cocoa, rice)	39	21.7%	
Agricultural Cooperative Membership	No	92	51.1%	
	Yes	88	48.9%	

Source: Researcher's Analysis, 2025.

The average age of study sample (n=180) was 45.2 years, showing that it consists mostly of middle-aged farmers. The age structure shows a relatively good distribution among the varying age groups with the highest numbers being the farmers aged 51-60 years (23.3%) and those aged 41- 50 years (22.8%). This age distribution indicates that experienced persons dominate farming in the study site as they have had several years to acquire the agricultural skills and understanding in farming. The representation of younger farmers in the 18-30 years bracket (17.8%) and the 31-40 years bracket (21.7%) means that there is some participation of young people in the farming sector though they make up a few percentages of the farming population. The minority were farmers above age 61 years (14.4%), which could be either the age at which the cohort retired or the age that the group died out.

The demographic of farming experience is consistent with the age distribution with an average participation of 12.8 years' experience in farming. The distribution demonstrates that the vast majority of farmers possess moderate to heavy experience as 29.4% of them worked 11-20 years and 28.3% of them 6-10 years. To be specific, 1 in every 5 farmers has more than 20 years of experience and this constitutes a treasure of traditional knowledge and agricultural practices. The availability of fresher farmers with 1-5 experiences (22.8%) also indicates that more farmers can still enter into the agricultural sector, which indicates sustainability of the sector and contribution to knowledge transfer.

Gender breakdown portrays a little higher proportion of females in the participants of the study with a female majority of 53.9% against 46.1% of the men. This observation is important because it indicates the key role of women in farming especially in developing world where women form a big percentage of the agricultural workforce. The close proportionality in gender also means that views and experiences of both men and women farmers will both be captured, leading to the results of the research being more representative and valid.

The educational level of the farmers is a mixed affair owing to the greatest proportion having primary school education (36.1%), and then secondary school (29.4%). Nonetheless, relatively high levels of illiteracy among the farmers (18.3%) reflect a limitation that could affect uptake and adoption of technologies, accessibility to information and engagement in formal agricultural initiatives. Only 16.1% of farmers are in the tertiary level meaning they are not well exposed to higher-level agricultural information including other professional training. This education picture implies the possibility of problems with the introduction of complicated agricultural technologies and the necessity of extension services and farmers educational programs.

Crops production activities demonstrate that there is a diversified farming system with maize being the most common crop (30.0%), followed by vegetables (27.2%) and cassava (21.1%). There is intensive production of major staple crops such as cassava and maize and this point toward food security and subsistence approach to farming with vegetable production signalling the existence of some market orientation. The other crops (21.7%), composed of yam, plantain, cocoa, and rice shows how diverse agricultural production is in the study area and reflects on the local ecologies and market requirements.

48.9% being members. This finding indicates that cooperative membership — while relatively prevalent — has not yet reached universal adoption, suggesting that targeted outreach efforts could meaningfully increase farmer participation in structured agricultural networks and, by extension, improve access to group-based insurance schemes.

Table 3. Demographic characteristics of Insurance firms

Characteristic	Category	Frequency	Percentage
Company	Custodian & Allied Insurance Limited	10	25.0
	Linkage Assurance Plc.	10	25.0
	Mutual Benefits Assurance Plc.	10	25.0
	Nigerian Agricultural Insurance Corporation (NAIC)	10	25.0
	Subtotal	40	100.0
Position	Top Management	21	52.5
	Middle Management	19	47.5
	Subtotal	40	100.0
Years of Experience	5-10 years	15	37.5
	11-17 years	16	40.0
	18-22 years	9	22.5
	Subtotal	40	100.0
Core Insurance Products	Crop insurance	29	72.5
	Farm asset insurance	29	72.5
	Livestock mortality insurance	27	67.5
	Area-yield insurance	25	62.5
	Agribusiness liability insurance	25	62.5
	Weather-index insurance	18	45.0
Specialized Products	Farm Machinery & Equipment Insurance	8	20.0
	Livestock Health & Specialized Coverage	8	20.0
	Comprehensive Farm Coverage	5	12.5
	Weather & Risk Management	3	7.5
	Specialized Agricultural Services	3	7.5
	Post-Harvest & Transport	2	5.0
	Other/Miscellaneous	3	7.5

Source: Researcher's Analysis, 2025.

The demographic profile reveals a well-balanced and representative sample drawn from Nigeria's agricultural insurance sector. The research accomplished excellent stratification with each of the four large insurance companies having 10 respondents or 25% of the entire sample. This uniformity among Custodian and Allied Insurance Limited, Linkage Assurance Plc., Mutual benefits insurance Plc. and the Nigerian agricultural insurance corporation ensures that the industry is not biased in evaluating the industry by leaving out any insurer.

There is great representation of levels of decision-making in these organizations according to the respondent hierarchy. Large proportions (52.5%) of the respondents are at the top management levels whereas middle management forms 47.5% of the respondents. This distribution can be of great use by researchers since they encompass both the viewpoints of strategic decision-makers and operational managers who can initiate the decision to use agricultural insurance. The slight slant towards the top management indicates there are strategic perspective and policy directions being indicated in these organizations in the data. A potential limitation of this distribution is that top management respondents may overstate institutional preparedness and understate operational-level challenges, introducing a social-desirability or optimism bias into responses on risk management and solvency. This was partially mitigated by the deliberate inclusion of 47.5% middle management respondents whose daily operational experience provides a counterbalancing perspective.

Experience levels among respondents indicate a mature and seasoned workforce in Nigeria's agricultural insurance sector. The most significant group comprising 40% has an experience of 11-17 years whereas, the next largest group

that recorded 37.5% has an experience of 5-10 years. The top 22.5% of the sample are senior professionals that have 18-22 years of experience. This composition proposes a balanced cohort between young-professionals with new ideas and old-timers with experience and a long institutional memory concerning how agricultural insurance in Nigeria has developed over time.

Analysis of service offering on the insurance product portfolio gives interesting patterns. Crop insurance and farm asset insurance emerge as the most prevalent products, each offered by 72.5% of respondents' organizations. This high penetration rate reflects the fundamental importance of protecting crops and farm infrastructure in Nigeria's agricultural landscape. Closely behind is livestock mortality insurance at 67.5% meaning that livestock is effectively acknowledged to be a major input in the Nigerian agricultural sector. Area-yield insurance and agribusiness liability insurance both come up with 62.5% penetration levels indicating that these products are becoming a common commodity. Weather-index insurance, less strategically significant than the other forms of insurance, has lower levels of 45% adoption rates, perhaps reflective of either lack of market readiness or the technicalities of implementation.

The specialized insurance products landscape demonstrates the sector's efforts toward diversification and innovation. Farm machinery and equipment cover and livestock health and specialized cover policy cover half each, 20% each, which is becoming clearer that the one-week crop coverage may not be sufficient and that other assets may be in need of associated comprehensive coverage. The percentage of comprehensive farm coverage packages is 12.5%, and it reveals the dynamic shift toward integrated insurance packages. The lower percentages of weather management products (7.5%) and risk management (7.5%) crops and products, as well as post-harvest and transport coverage (5%) seem to indicate that they are only partially developed and mostly niche products. This product mix profile shows that although Nigerian agricultural insurers have found firm grounds in the protection of traditional crops and assets, there is a great scope in which they can expand into more advanced risk management - based products encompassing the entire value chain in agriculture.

RESEARCH QUESTION TWO: What are the types of extreme weather events affecting crop production in the study area?

Table 4. Extreme weather events affecting crop production in the study area

Weather Event	Response	Frequency*	Percentage
Flooding	YES	100	55.6%
Drought/Dry Spells	YES	102	56.7%
Severe Storms	YES	117	65.0%
Erratic Rainfall	YES	111	61.7%

Source: *Researcher's Analysis, 2025*

*Multiple responses recorded

The weather events data reveals the pervasive and multifaceted nature of climate-related challenges facing Nigeria's agricultural sector. This is evidenced by the fact that a combination of multiple weather-related risks is being faced by agricultural stakeholders and according to the timing of the events that respondents cited, weather events are overlapping as opposed to non-repeated risks. Severe storms emerge as the most prevalent weather challenge, affecting 65.0% of respondents' agricultural operations. Such a high prevalence rate indicates that the most vivid and all-encompassing threat to agricultural productivity in the study area is intensive weather with high winds, rainfall, and, possibly, damage. The specific agricultural impact of severe storms was measured through self-reported financial loss data collected in Section B of the farmer questionnaire (Table 6), where respondents estimated their crop losses in Naira per season attributable to storm events. This yielded a mean storm-related crop loss of ₦87,544.44 per farmer in 2020, the highest of all weather event categories, confirming both the prevalence and the financial severity of storm impacts on agricultural livelihoods in the study area.

Unpredictable rainfall is a major premise of agricultural success as seen as 61.7% of the respondents are subject to these rains. This frequency is high, showing that the current traditional farming systems, which have rested on predictable rains patterns, are being altered by increasingly variable weather patterns.

Drought and dry spells impact 56.7% of agricultural operations, representing a critical challenge for rain-fed agriculture that dominates much of Nigeria's farming systems. The drought conditions experienced are of high frequency and such a situation implies that water scarcity as a type of risk can no longer be described as periodic but rather, recurring thus substantially changing the nature of risk to a farm investment.

The fact that flooding covers 55.6% of respondents is representative of the lowest level of prevalence of weather events feature under survey. Nevertheless, the given percentage shows that over half of farming activities are exposed to flood-related risks, proving that flood conditions may severely affect farming activities due to the excessive amount of water. The fact that flooding and drought situations (56.7) as well as the same sample population makes evident the fact that weather patterns are quite unpredictable and agricultural activities have to be able to protect against both drought conditions and flooding situations.

It is the combined occurrence of these weather events that constitutes an unfavourable operational climate in which agricultural stakeholders have to deal with consequent contrary risks all at once. The overlap of these weather risks indicates that efficient agricultural insurance products should be formulated with a scope and flexibility to take into consideration a number of complex situations rather than individual weather risk occurrence perils in their own right.

RESEARCH QUESTION THREE: What is the Level of Risk Exposure of Crop Farmers to Climate-Induced Disasters?

Table 5: Level of Risk Exposure of Crop Farmers to Climate-Induced Disasters

Level of risk exposure	Low Exposure	High Exposure	Mean	Std. Deviation	Exposure Level
Risk from flooding	1	5	3.10	1.286	Medium
Risk from drought	1	5	3.06	1.379	Medium
Risk from heat waves	1	5	2.87	1.160	Medium
Risk from post-event pest outbreaks	1	5	3.02	1.288	Medium
Risk from market fluctuations post-event	1	5	2.92	1.186	Medium
Valid N (listwise)					

Note: Low exposure: 1.00 - 2.33; Medium exposure: 2.34 - 3.66; High exposure: 3.67 - 5.00

Source: *Researcher's Analysis, 2025*

Objective II to be analysed is: To examine the degree to which crop farmers in the study area were exposed to climate-induced disasters given the provided descriptive statistics. The descriptive statistics are similar in terms of a moderate exposure to climate risk on every dimension. The five risks ranked on the risk-associated weather changes ranked between medium exposure with a mean between 2.87 and 3.10 on the 5 levels scale. It can be interpreted to imply that 180 respondents included in the study are moderately exposed to all four dimensions of climate risks, neither being deeply worried that they are and cannot be exposed, and nor are they blithe.

When considering the scale of perceived risks, the flood is the largest concern among the respondents expressing an indication of 3.10 which is not far to the highest degree of exposure in the medium range. Drought risk is imminently followed by 3.06, and again, has the highest standard deviation of 1.379, indicating a wide range of revelation or perception of drought related insecurities. The rest of the risks sit in lower-medium band, with post-event pest outbreaks at 3.02, market fluctuations post-event at 2.92 and heat waves as the least perceived risk placing at 2.87 yet still landed in the middle exposure category.

The dynamics of the variability of the data also give more information on the type of risk perceptions of the sample. It is observed that drought risk presents the highest level of heterogeneity because its standard deviation is 1.379, meaning that some respondents might consider it as a serious threat, whereas others might find it relatively straightforward to deal with. Heat wave risk, on the other hand, exhibits the least variability: the standard deviation is 1.160, which highlights greater similarity in the experience/perceptions between respondents in relation to heat-related risks. The relatively high standard deviations of all risk categories (all well above 1.0) show that variation in individual risk scores is large, indicating that different vulnerability profiles exist in the study population.

As evident in the analysis, the smallholder crop farmers are largely exposed to the climate induced disasters. This can be easily traced in the popularity of the broadcasting of money loss and crop destruction among the surveyed population. This finding also aligns with the background of the research that states that such farmers as smallholders are the most susceptible categories in the face of climate change variability's and extreme weather conditions (Li & Pu, 2024). The level of exposure identified demonstrates the need of the adopted interventions, which is recognized by the Federal Ministry of Agriculture (2019), which states that the smallholder farmers of Nigeria do not always have the technologies, financial means, and infrastructures to endure such shocks.

RESEARCH QUESTION FOUR: What are the financial losses incurred by farmers as a result of extreme weather events (2020-2024)?

Table 6. Descriptive Statistics of Financial Losses Incurred By Farmers As A Result Of Extreme Weather Events (2020–2024)

Items	N	Minimum	Maximum	Mean	Std. Deviation
Flooding crop loss in 2020	180	0	500000	81000.00	118390.781
Drought crop loss in 2020	180	0	420000	54547.22	86652.966
Storm crop loss in 2020	180	0	450000	87544.44	117591.344
Other crop loss in 2020 (pest outbreaks, hail damage, and extreme temperature events)	180	0	450000	35732.22	72983.343
Valid N (listwise)	180				

Source: Researcher’s Analysis, 2025

The monetary losses that were experienced as a result of extreme weather conditions in 2020 as depicted in table 4.1.11 were quiet high and also depended very much on the phenomenon experienced. The storms incurred the highest financial losses and its average crop loss per farmer was 87,544.44 Naira. Flooding immediately followed this and the result was average loss of 81,000.00 naira. Losses due to drought were significantly fewer and their average is ₦54,547.22 whereas other miscellaneous events were the least costly financially on average (₦35,732.22). The data indicates a high range of the impact, with the highest individual losses amounting to ₦500,000 as a result of a single incident of flooding, and outlining a possibility of financial disaster of devastating scale of some farmers.

The report established that farmers incurred heavy losses due to the extreme weathers experienced in the year 2020-2024. The discovery is a direct empirical support of the problem statement, which postulates that disruptions arising as a result of climate tend to result in drastic loss of income, indebtedness, and loss of household properties (Federal Ministry of Environment, 2021). This economic burden to farmers is indicated by the statistics of surging food inflation (NBS, 2023) and the reported losses in crop production (Adah et al., 2016). which all point towards the immense adverse economic effects on the household of farmers.

The financial losses presented in Table 6 are based entirely on farmer self-reported estimates collected through the structured questionnaire. Respondents were asked to recall and estimate their annual crop losses in Naira attributable to each weather event category for the period 2020–2024. No official government or insurance industry statistical records were used for the farmer loss figures.

RESEARCH QUESTION FIVE: What is the Accessibility and Uptake of Agricultural Insurance?

Table 7. Accessibility and Uptake of Agricultural Insurance

Characteristic	Category	Did Not Purchase	Purchased	Total	Purchase Rate
Gender	Male	34	49	83	59.0%
	Female	51	46	97	47.4%
Education Level	No formal education	26	7	33	21.2%
	Primary	32	33	65	50.8%
	Secondary	22	31	53	58.5%
	Tertiary	5	24	29	82.8%
Farming Experience	1-5 years	31	10	41	24.4%
	6-10 years	29	22	51	43.1%
	11-20 years	19	34	53	64.2%
	Over 20 years	6	29	35	82.9%
Main Crop Type	Cassava	21	17	38	44.7%
	Maize	29	25	54	46.3%
	Vegetables	12	37	49	75.5%
	Others	23	16	39	41.0%
Cooperative Membership	Not a member	60	32	92	34.8%
	Member	25	63	88	71.6%
TOTAL		85	95	180	52.8%

Source: Researcher’s Analysis, 2025

In table 7, Objective V can be met that seeks to analyse the uptake and ease of accessing agricultural insurance during the period 2020 to 2024. The provided data offers insights into the factors influencing farmers' decisions to purchase insurance and their perceptions of its accessibility. In general, 52.8% of the surveyed farmers were found to have purchased agricultural insurance at the specified period signifying that more than half of the sampled farmers had embraced agricultural insurance at the specified time.

In exploring the uptake nature, it is visible that there are several demographic and operational determinants, which seem to impact the adoption of insurance. There was a strong correlation of education level with the adoption of insurance, although there is an upward trend since the lowest purchase was recorded at 21.2% amongst farmers with no education, through primary (50.8%), secondary (58.5%) education and all the way up to 82.8% in those with tertiary education. This explains why education is very important in perception and appreciation of agricultural insurance. On the same note, experience in farming was also a very important factor, where more experienced farmers showed larger rates of uptake. Thanks to the rise in the number of farmers with more than 20 years' experience, who bought some insurance however, which was 82.9%, as compared to 24.4% of farmers who had been in the field between 1-5 years, it is evident that they might have experienced the greatest losses in farming, hence they are more appreciative of risk mitigation tools as insurance.

In terms of crop types, highest purchase rate of 75.5 was exhibited by farmers who grow vegetables as compared to other farmers who grow cassava (44.7), maize (46.3) and others (41.0). This difference may indicate that vegetable growers may see greater than average risk or more value to them to insure a particular crop. Among the most powerful determinants of uptake was cooperative membership; those members of cooperatives made a much higher purchase of 71.6% over non-members, making the purchase at 34.8%. This clearly means that there is a possibility that cooperative structures can help in accessing information, collective bargains or mutual support, which would increase the adoption of insurance.

This research revealed that the overall take-up level of agricultural insurance by smallholder farmers was 52.8%, which included a significant gender gap, with a purchase rate among males (59.0%) being higher as compared to that of the female counterparts (47.4%). Regarding access, the results indicate that even though farmers have mostly positive attitude towards trust in providing companies and the simplicity of application, affordability of costs (lowest means score of 2.94) is rated as the main access barrier. This observation provides a strong argument to the claim made in the problem statement and background to the study that, among other factors, the low uptake of agricultural insurance in Nigeria is caused by affordability and its perceived lack of trust (World Bank, 2022).

RESEARCH QUESTION SIX: What is the volume of claims due to agricultural risks (2020–2024)?

Table 8. Descriptive Statistics for the Volume of Claims Due To Agricultural Risks (2020–2024)

	N	Minimum	Maximum	Mean	Std. Deviation
CLM_YEAR_2020_CLIMATE_NUM	40	1	35	8.55	7.599
CLM_YEAR_2021_CLIMATE_NUM	40	2	33	10.70	8.343
CLM_YEAR_2022_CLIMATE_NUM	40	1	40	11.30	8.450
CLM_YEAR_2023_CLIMATE_NUM	40	2	45	12.60	9.922
CLM_YEAR_2024_CLIMATE_NUM	40	1	50	13.43	10.789
CLM_YEAR_2020_CLIMATE_VAL	40	.9000	5400000.0000	1088125.317500	1283595.4065471
CLM_YEAR_2021_CLIMATE_VAL	40	1.1000	5800000.0000	1189750.395000	1402178.4639325
CLM_YEAR_2022_CLIMATE_VAL	40	1.00	6000000.00	1213375.3525	1427049.56418
CLM_YEAR_2023_CLIMATE_VAL	40	1.20	6200000.00	1288375.3737	1523142.78013
CLM_YEAR_2024_CLIMATE_VAL	40	1.0000	5600000.0000	1163750.375000	1240606.4574512
CLM_YEAR_2020_OTHER_NUM	40	1	25	7.22	6.028
CLM_YEAR_2021_OTHER_NUM	40	1	27	8.10	6.559
CLM_YEAR_2022_OTHER_NUM	40	2	30	8.48	6.910
CLM_YEAR_2023_OTHER_NUM	40	2	32	9.33	7.560
CLM_YEAR_2024_OTHER_NUM	40	1	35	9.20	8.480
CLM_YEAR_2020_OTHER_VAL	40	.4000	950000.0000	306625.240000	251702.7948159
CLM_YEAR_2021_OTHER_VAL	40	.6000	1100000.0000	338250.330000	274517.0205929
CLM_YEAR_2022_OTHER_VAL	40	.50	1050000.00	338750.3413	277981.94908
CLM_YEAR_2023_OTHER_VAL	40	.6000	1200000.0000	363325.363750	301151.6904066
CLM_YEAR_2024_OTHER_VAL	40	.5000	1000000.0000	333500.285000	248707.7223349
Valid N (listwise)	40				

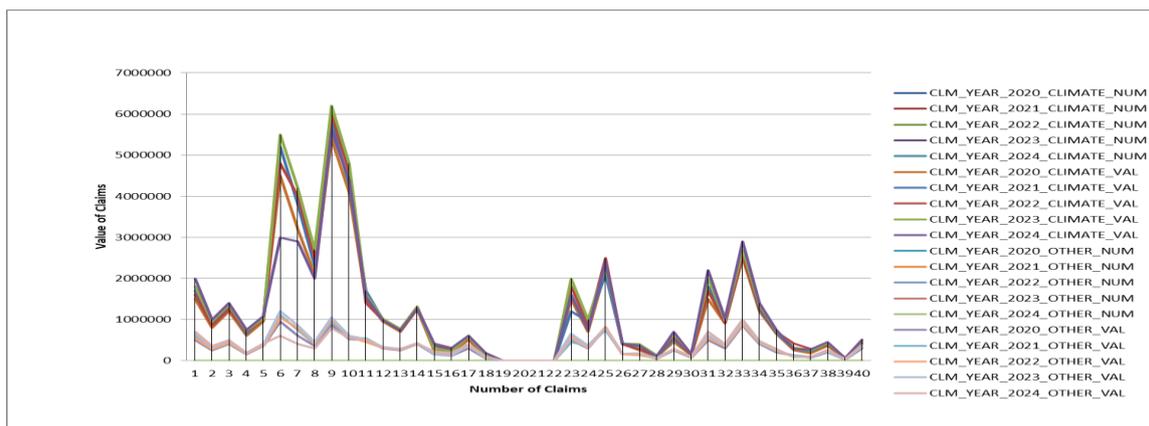


Fig. 1. Volume of Claims Due to Agricultural Risks (2020–2024)

The data is broken into two broad categories of agricultural risks namely, climate-related and other risks and the data of the number of claims (NUM) as well as the value of claims (VAL) is presented by year, i.e., 2020-2024. The sample size (N) of all the variables is homogenous (40). It means that 40 observations were taken per measure year by year. For climate-related claims, specifically, there's a noticeable increasing trend in the mean number of claims over the five-year period. It begins at a national average of 8.55 in 2020 and goes steadily up to 13.43 in 2024. This implies that there is an increasing trend of insurance paid out due to climate related agricultural risks. Its maximum value, expressed in the number of claims, also demonstrates an increasing trend reaching the highest points of 50 in the year 2024, which is equal to the cases of a particularly high number of claims in some observations. The standard deviation of climate-related claim levels also tends to rise, 7.599 in 2020 up to 10.789 in 2024. This shows that the number of claims made in relation to climate is increasing over time, i.e., the data points would have a wider distribution around the means.

As far as the value of climate-related claims is concerned, average values tend to approximately orbit in the N1 million to N1.2 million range, with certain bumps and dips. The best mean value is found in the year 2023 at N1, 288,375.37 and in 2024 a small decrease is witnessed as compared to the previous year at N1, 163,750.38 although the number of claims is also increasing. The high value of claims is quite high constantly in millions with the high value being N6, 200,000 in the year 2023. The standard deviation on claim values is also very high and normally beats the mean indicating that there is very high variation in the financial consequence of climate-related claims. This indicates that the increases may be in the number of claims but their financial severity can widen quite dramatically.

For other agricultural risks there's also a general upward trend in the mean number of claims, from 7.22 in 2020 to 9.20 in 2024, although 2024 shows a slight dip compared to 2023. The peak claims on this category also increase, where they will reach 35 in the year 2024. The standard deviations of other risk claim numbers have minor variations though they depict an equal variability in general.

With respect to the amount of claims that have occurred due to other agricultural risks the means of these values are relatively low compared to climate-related claims with a general lower value between N300, 000 to N360, 000. The largest mean value is given for 2023 which is N363, 325.36. These claims also have their maximum claims much less than climate-related claims with up to N1, 200,000 in 2023. The standard deviation of the value of the other claims is also large in comparison to the mean which means that this category is highly variable in terms of finances and the level of variability is appreciably lesser than claims pertaining to climatic changes.

The general trend of the volume of claims is evident in the data provided, as there was an overall growth in the volume of claims both in the volume and the monetary costs by 2024 compared to the year 2020. The number and particularly the monetary value of claims due to climate-related risks seem to be the most prevailing in the sense of their number and particularly their monetary value and have larger means and maximums than other risks in this category (i.e., agriculture). The large standard deviations on all variables reflect high amount of variation and unpredictability of the frequency and financial magnitude of the agricultural claims. This implies that as much as the trend is an increase, there are variations in terms of the volumes and value of claims made in varying observations and years. The data yields an open- and-shut quantitative base to perceive the rate and dynamic character of agricultural demands during the given duration, which directly benefits the Objective VI.

Insurance firms' claims analysis data showed a worldwide and strong rising pattern in the amount of claims legitimized against agricultural hazards between the year 2020 and 2023. Such assertions can be proved by the fact that the average number of claims has been increasing over the years with 8.55 in 2020 to 12.60 in 2023. The trend towards more and worse cases of extreme weather events impacting the agricultural sector is manifested in this particular upward curve on its claims, which has also been regularly reported by the IPCC (2021). The findings are also in line with the problem statement's observation that post-flood claims in 2022 exceeded the Nigerian Agricultural Insurance Corporation's (NAIC) annual risk capital by 30% (NAIC, 2023). This relationship between the increasing volume of claims and climate-related disasters shows that there is a serious gap in the insurance mechanisms of the country. It is acknowledged that the claims trend analysis in this section is descriptive and does not include formal tests of statistical significance (e.g., Mann-Kendall trend test or regression-based trend analysis). This is a limitation of the study: with only five data points (2020–2024) and a single-institution sample (n=40), inferential trend analysis would have limited power. Future research with longer time series and larger cross-sectional samples should apply formal trend-significance tests to validate the patterns observed here.

RESEARCH QUESTION SEVEN: What is the financial impact of claims on insurance firm solvency?

Table 8. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.973 ^a	.947	.945	1.780

a. Predictors: (Constant), FINANCIAL_IMPACT

Table 9. ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2131.518	1	2131.518	672.839	.000 ^b
	Residual	120.382	38	3.168		
	Total	2251.900	39			

a. Dependent Variable: INSURANCE_FIRM_SOLVENCY

b. Predictors: (Constant), FINANCIAL_IMPACT

Table 10. Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.838	.458		-1.828	.075
	FINANCIAL_IMPACT	.745	.029	.973	25.939	.000

a. Dependent Variable: INSURANCE_FIRM_SOLVENCY

Source: Researcher's Analysis, 2025

This analysis was mainly aimed at determining the financial implication of claims on the solvency of insurance firms. To do this, a regression model was established such that the dependent variable is Insurance_Firm_Solvency and predictor is Financial_Impact. The findings give effective results on the impact of these variables. According to Model Summary, a strong relationship is represented. The Pearson correlation coefficient (R = .973) confirms a very strong positive linear association between the financial impact of claims and insurance firm solvency. The coefficient of determination (R² = .947) indicates that 94.7% of the variance in solvency scores is statistically explained by the financial impact of claims alone. The Adjusted R² of .945 closely mirrors the R², confirming that the model's explanatory power is not an artefact of over-parameterisation and remains robust after adjusting for sample size. The Standard Error of the Estimate, 1.780, gives some indication of the average difference between the measured states of solvency and that of the model.

The significance of the regression model is attested statistically by the ANOVA table. The model is highly significant in the statistics since F-statistic = 672.839 and significance, or p-value = .000 (less than 0.05). This implies that the estimates of financial impact of claims as predictors overall helps in explaining the changes in the solvency of insurance firms. More colloquially, the model is highly superior as a predictor of solvency as compared to plain using the average of solvency.

Lastly, the Coefficients table presents knowledge on the peculiarities of the relationship. Financial_Impact has unstandardized (B) 0.745. This implies that, with an increment of one-unit in the financial severity of climate-related claims in 2023, the solvency of the insurance firm is expected to rise by .745 units with other parameters held constant. The Beta statistic of .973 also underscores the substantial positive effect of financial impact on the solvency since it

indicates the standardized regression in a dependent variable, i.e., the effect of a 1 standard deviation change in predictor. The t-statistic of 25.939 and a significance (p-value) of .000 of this predictor attests to the fact that the financial effect of claims is an extremely important predictor of solvency of an insurance firm. The regression intercept (constant = $-.838$) is not statistically significant ($p = .075$), indicating that it is not meaningfully different from zero. This is expected in this model context: it means that when the financial impact of claims is hypothetically zero, the predicted solvency score approaches zero – an implausible real-world scenario. The substantive interpretation therefore rests on the slope coefficient ($\beta = .745$, $\beta = .973$, $p < .001$), which robustly confirms the strong positive relationship between claim severity and insurer solvency.

The regression reveals an interesting observation that financial impact of claims is highly strong and statistically significant, which has a strong relationship with solvency of insurance firms. Based on the model, the financial impact of claims can comfortably evaluate the variance in solvency by about 94.7%, which qualifies that solvency is very sensitive to claim payments. This observation is in concurrence with this study by Modilim (2025) that found that the level of physical risks due to extreme weather exposure is positively correlated but moderate with the number of claims frequency and severity thus it influences the risks pricing and modeling.

RESEARCH QUESTION EIGHT: What are the challenges faced by insurance firms?

Table 11. Challenges Faced By Insurance Firms

Challenge	Not Significant	Slightly Significant	Moderately Significant	Significantly Significant	Very Significant	Total
Pricing difficulty	1 (2.5%)	13 (32.5%)	12 (30.0%)	11 (27.5%)	3 (7.5%)	40 (100%)
Lack of data	3 (7.5%)	12 (30.0%)	14 (35.0%)	11 (27.5%)	0 (0%)	40 (100%)
Admin costs	3 (7.5%)	12 (30.0%)	9 (22.5%)	14 (35.0%)	2 (5.0%)	40 (100%)
Moral hazard/adverse selection	4 (10.0%)	21 (52.5%)	13 (32.5%)	2 (5.0%)	0 (0%)	40 (100%)
Regulatory constraints	3 (7.5%)	15 (37.5%)	12 (30.0%)	10 (25.0%)	0 (0%)	40 (100%)
Low demand/awareness	5 (12.5%)	15 (37.5%)	10 (25.0%)	8 (20.0%)	2 (5.0%)	40 (100%)

Source: Researcher's Analysis, 2025

Based on responses from participants, the findings demonstrate distinct patterns of concern that provide valuable insights into the primary obstacles facing implementation efforts. Administrative costs emerge as the most pressing concern, with 35% of respondents rating it as significantly significant and an additional 5% considering it very significant. This means that 40% of participants view administrative costs as a major barrier, representing the highest concentration of severe concern among all categories examined. The cumulative impact is substantial, with 95% of respondents indicating at least some level of significance regarding administrative costs, suggesting this is a nearly universal concern that varies primarily in degree rather than presence.

Pricing difficulty and lack of data present comparable challenges, each affecting respondents with similar intensity but different distribution patterns. For pricing difficulty, 35% of participants rate it as either significantly or very significant (27.5% and 7.5% respectively), while the remaining responses are relatively evenly distributed across moderate (30%) and slight (32.5%) significance levels. Lack of data shows a different pattern, with 35% rating it as moderately significant and 27.5% as significantly significant, but notably no respondents considered it very significant. This suggests that while data availability is a consistent concern, it may be viewed as more manageable than other barriers.

Regulatory constraints occupy a middle position in terms of perceived severity, with exactly one-quarter of respondents (25%) rating it as significantly significant. However, the majority of concerns cluster in the lower significance categories, with 37.5% rating it as slightly significant and 30% as moderately significant. This distribution suggests that while regulatory issues are recognized as obstacles, they may be viewed as more navigable or less immediately threatening than administrative and pricing challenges.

Low demand and awareness issues show a relatively moderate impact profile, with only 25% of respondents rating it in the highest significance categories (20% significantly significant, 5% very significant). The largest concentration of responses falls in the slightly significant category at 37.5%, indicating that while market awareness is recognized as a factor, it may not be perceived as the primary barrier to overcome.

Moral hazard and adverse selection concerns represent the least severe challenge according to respondent perceptions, with the vast majority (52.5%) rating it as only slightly significant and just 5% considering it significantly significant. No respondents rated this challenge as very significant, and only 32.5% viewed it as moderately

significant. This pattern suggests that while these economic concepts are recognized as relevant considerations, they may not pose immediate practical barriers to implementation in the respondents' specific contexts.

The overall pattern emerging from this data indicates a clear hierarchy of implementation challenges, with operational and financial barriers (administrative costs, pricing difficulty, and data availability) taking precedence over market-based concerns (demand/awareness) and theoretical economic issues (moral hazard/adverse selection). The relatively moderate concern about regulatory constraints suggests that while compliance requirements are acknowledged, they may be viewed as standard business considerations rather than prohibitive obstacles.

The potential obstacles to efforts of the insurance companies in offering agricultural cover against the climate change risks were found to be difficulty in pricing, unavailability of data, higher administrative expenditures, the matter of moral hazard and adverse selection, regulatory barriers, and feeble demand/knowledge among farmers. These results validate the literature that identifies the dynamics of agricultural insurance market in Nigeria. The pricing challenge and the lack of data are especially strong, since those make it hard to provide viable actuarial models and offer such products as weather-index insurance. The peril of moral hazard and adverse selection, that farmers can become more risk-prone as long as they are insured or that the farmer with the highest risk is most inclined to obtain insurance, is a widely known complex in the provision of insurance funds (Pingali, 2017). It may also be impossible to provide the firm with an opportunity to work profitably due to regulatory restrictions and excessive administration expenses, and a low level of demand and awareness among the target audience further stifles market growth (Ajayi & Adeleke, 2021; Shee et al., 2019). All these make the management of risks and solvency of the insurance firms inefficient.

5. Conclusion

This study, an assessment of the financial impact of climate-induced extreme weather events, found a significant link between climatic shocks and the economic stability of smallholder farmers and agricultural insurance firms in Lagos State, Nigeria. The study, characterized by survey-based method, found out severe storms, floods, and droughts to be the most common and the most influential type of extreme weather that affects crop production. These events were perceived to result in big and multi-dimensional financial losses to farmers and the fact has been established to be highly statistically significant. The losses are usually not just in terms of direct destruction of crops and loss of yield in farms, but also destruction of farm infrastructure critical to making their livelihood meaningful, the loss of the household savings and all that it took to take up agriculture, and increased debts, which challenge the sustainability of their means of livelihoods.

In this case of insurance of agriculture, the study revealed a huge difference. Though a significant proportion of farmers (52.8%) have embraced insurance, it is clear from the results that there is a significant knowledge gap as well as different levels of uptake among the farmers specifically with regard to the demographic factors notably gender and levels of education. Moreover, the relationship between agricultural claims financial effects and insurance firm's solvency proved very strong and had a strong positive correlation during the analysis.

The research definitively concludes that climate-induced extreme weather events pose a severe and multifaceted threat to Nigeria's agricultural and financial sectors. The economic hurt inflicted by these developments is not only felt by small farmer producers but also goes unequivocally directly to financial stability of agricultural insurance companies, making this an unstable and connected network of risk. The research conducted has strong empirical proofs on how the existing insurance system in agriculture is not perfectly industrialized to the magnitude and recurrence of current climatic shocks. The gaps that currently exist in terms of enlightenment of the farmers, accessibility and financial risk of the insurance providers form a self-perpetuating risk cycle. Farmers have no trust with a system that seems uncertain of its financial future and insurers are operating in a high-risk environment since it is difficult to provide an affordable and comprehensive coverage. This cycle compromises the endeavors of increasing the climate resilience to achieving long-term food security of the region. Owing to the successes of this study, the following recommendations are suggested so as to develop the stronger agricultural and financial system in Nigeria:

- i. The government agencies and NGOs are to work on the development and publication of localized climate-smart farming strategies due to the high occurrence rates and negative consequences of extreme weather events, floods, and droughts. This involves encouraging the use of draught resistant crops,

- better irrigating methods on the draught prone areas and strong drainage systems on flood prone areas to safeguard crops and the health of the soil.
- ii. The government must also make small holder farmers especially those in marginal lands practically gain access to technology, weather forecasting services and finances that help them cater to and curb climatic risks.
 - iii. The close connection between the assertion and the solvent health of firms implies that there has to be a systemic overhaul of prevailing structural practices in business to make them sustainable in the future. Insurance companies are advised to consider creating duration sensitive and index based insurance products that will be better with overcoming the systemic and high payout hazards of climate change. An example would be an index-linked product that pays out automatically when a pre-designated weather parameter is reached (i.e. rainfall level) instead of being dependent upon expensive and lengthy manual damage inspections.
 - iv. Moreover, companies ought to invest in deep data gathering and more complex risk projections in order to properly price premiums, better manage their reserves and prevent liquidity emergency driven by large-scale climate-related calamities.
 - v. To overcome the noted differences in the adoption of insurance, policies must be drawn in a way that will aggressively support the concept of inclusivity by targeting female farmers and other people with lower educational degrees. This may include instituting special programs that can reach the targeted areas and ease the insurance applications.
 - vi. To increase awareness on the essence and gains of agricultural insurance, campaigns on financial literacy involving trusted local community leaders and word-of-mouth channels, which proved to be very influential, should be launched to inform the farmers on the necessity and advantages of agricultural insurance.
 - vii. Public-private partnerships may also be considered to allocate risks and subsidize premiums to afford and make insurance more available to the poorest of smallholder farmers and hence breaking the risk circle-identified dynamic in this research report.

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ETHICAL AND SCIENTIFIC PRINCIPLES STATEMENT OF RESPONSIBILITY

The authors declare that ethical rules and scientific citation principles were complied with throughout the preparation process of this study.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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