Risks and Resilience of Agro-Logistics

Emmanuel Ukpe, PhD

School of Business, University of the Virgin Islands, St. Croix, United States, Virgin Islands.

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ABSTRACT

Northern Nigeria's agro-logistics sector faces growing challenges, partly due to declining research funding, which threatens the regional food system's security. This study examined the dual impact of research funding cuts on agro-logistics in Adamawa, Borno, Yobe, and Kaduna States. We conducted a cross-sectional survey of 1,200 respondents, including agro-logistics firms, research institutions, and extension officers, using a structured questionnaire. We analyzed responses using descriptive statistics, exploratory factor analysis, and multiple linear regression, which showed that insecurity significantly disrupted logistics operations ($\beta = -0.286$, $p < 0.001$). Although insecurity reduced support for research and innovation and weakened logistics resilience ($\beta = -0.193$, $p < 0.001$), years of experience and institutional affiliation were positively linked to strategies for maintaining operations. The study recommends restoring research funding and implementing multi-level security measures. Additional suggestions include public-private partnerships to foster innovation adoption and capacity building for institutions and extension systems, as well as to promote resilience in Northern Nigeria's agro-logistics.

Keywords: Agro-logistics, Insecurity, Research Funding, Supply Chain Resilience, Northern Nigeria.

1. INTRODUCTION

Nigeria's agro-logistics sector plays a crucial role in supporting the country's food systems and rural economies, especially in the northern regions where agriculture is a significant source of livelihoods. The sector, which enables the efficient movement and management of agricultural products from farms to markets (Liping, 2012; Bosona & Gebresenbet, 2012), suffers from a fragmented transport network and inefficient management, resulting in reduced post-harvest quality and increased prices. According to Okolo (2016), poor road maintenance, outdated railway systems, and inadequate planning for shipping goods hinder Nigeria's transportation network, negatively affecting agricultural supply chains and contributing to sociopolitical unrest (Alhassan & Risikat, 2024). Additional issues include insufficient cold chain infrastructure, a lack of refrigeration units, freezers, and storage facilities necessary to maintain the freshness of perishable goods (Stathers et al., 2024).

Furthermore, over the past twenty years, Northern Nigeria has become a hotspot for various violent conflicts that have disrupted the continuity of agricultural activities. The escalation of Boko Haram insurgency, armed banditry, and farmer-herder clashes has destabilized both the social fabric and economic infrastructure of the region. Studies by Amare et al. (2025) and Aigbedion et al. (2019) show that reduced mobility, increased theft, and higher transaction costs drive these disruptions and force enterprises to downsize operations. These disruptions also affect landowners, migrant laborers, and producers' access to fragmented suppliers, leading to subsistence farming and even total abandonment of the sector (Asaleye et al., 2023), which has entrenched economic stagnation in rural areas, with long-term risks to the productivity of the sector and the resilience of regional agriculture.

Under these conditions, research and innovation play a crucial role in strengthening logistics infrastructure, thereby enhancing agro-logistics resilience. Empirical evidence shows that sustained investment in agricultural research fosters context-specific technologies, optimizes value chains, and strengthens national food security (Kimenyi et al., 2014). However, the Agricultural Research Council of Nigeria (ARCN) has failed to perform its primary functions. According to a comprehensive assessment by Babu et al. (2017), the failure is attributed

to the ARCN's poor management and inadequate institutional capacity to supervise and coordinate research activities that enhance agricultural productivity, marketing, and competitiveness by developing appropriate technologies, policy options, and knowledge management for the agricultural sector. This assessment is based on establishing the national Agricultural Research and Extension system and strengthening the interface between research organizations and practitioners. Agwu et al. (2023) also report that agricultural extension services in Nigeria have lost effectiveness because poor research-extension-farmer networks and understaffing hinder innovation diffusion. Bradley (2017) links these failures to insufficient funding for research and innovation, driven by an overreliance on donor-funded infrastructure development (Hussain, 2016; Falana, 2024). Sabo and Abubakar (2020) relate failures to government corruption and the politicization of security responses to economic and socio-political crises.

Armstrong and Pauls (2021) warn that limited research funding not only stifles creativity and innovation but also weakens the ability to develop long-term solutions to local and international demands. Ogwuru, Okoro, and Ndubuisi (2022) highlight that limited research funding prevents scholars from accessing regional field data, leading to superficial, unempirical studies and poorly informed policies. The lack of funding also poses a dual threat to the sustainability of regional agro-logistics and the adoption of technology.

Accordingly, this study aims to analyze the dual impact of research funding cuts on security and resilience in Northern Nigeria's agro-logistics.

The Quad's overarching organization of this paper includes: A literature review to discuss A***gro-logistics and Food Security in Sub-Saharan Africa, The Role of Research and Innovation in Supply Chain Resilience, Insecurity and Business Disruption in Fragile States, and Gaps in the literature***; (ii) to analyze the impact of declining research and innovation support on logistics resilience; (iii) to assess the strategies adopted by enterprises to maintain continuity amid these challenges; and (iv) to identify the predictors of logistics resilience for continuity in the area. Through this multidimensional analysis, the research seeks to generate policy-relevant insights into how the Nigerian government and development partners can better support agro-logistics actors during periods of crisis, while also revitalizing research and innovation ecosystems for long-term agricultural transformation.

2. LITERATURE REVIEW

2.1 Agro-logistics and Food Security in Sub-Saharan Africa

Agro-logistics encompasses the infrastructure, institutions, and processes that facilitate moving agricultural products from production zones to final consumers. In Sub-Saharan Africa, agro-logistics systems include transportation networks (roads, rail, and waterways), storage facilities (warehouses), processing infrastructure, market access systems, and institutional arrangements for regional and international trade and distribution. Efficient agro-logistics systems reduce postharvest losses, stabilize market prices, and increase farmers' income, directly contributing to food security. Okolo (2006) affirms that, in addition to low productivity, food insecurity in Nigeria is exacerbated by supply chain failures, including inadequate transport infrastructure and a lack of postharvest handling.

According to Stathers et al. (2024), approximately 40% of perishable agricultural produce in Nigeria is lost due to inadequate inventory and storage facilities. Such inefficiencies are particularly harmful in unstable systems, where agricultural production can be highly variable and consumer demand is high. In addition, agro-logistics systems in the region are typically dispersed and poorly organized, increasing transaction costs and limiting market integration. The lack of an integrated transport system (Okolo, 2016) also hinders efficient goods transport, leaving sub-Saharan African countries highly prone to food crises.

2.2 The Role of Research and Innovation in Supply Chain Resilience

Research and innovation are crucial for developing resilient agro-logistics systems that can adapt to shocks such as climate change, economic volatility, or conflict. Investment in agricultural research supports the creation and sharing of innovations that can boost productivity, reduce postharvest losses, and improve market

efficiency. Babu et al. (2017) pointed out weaknesses in the institutional arrangements of agricultural research in Nigeria, noting that the Agricultural Research Council of Nigeria (ARCN) operates under a split-governance system, shows poor political impartiality, and lacks coordination with universities, national agricultural research institutes (NARIs), and the private sector. These structural issues have hindered the flow of innovations into Nigeria's agro-logistics systems.

Similarly, Agwu et al. (2023) argue that Nigeria's extension services are underfunded, poorly coordinated, and unable to facilitate effective innovation diffusion. These shortcomings have limited farmers' and logistics actors' access to essential innovations such as improved storage techniques, cold chain systems, and transport modeling tools. Financial resources are also a pressing concern. According to Igben and Etadafe (2023), financial constraints hinder the production of high-quality research products in Nigerian universities, thereby limiting their effectiveness in addressing pressing agricultural issues. Agro-logistics, combined with ICTs, satellite monitoring, and predictive analytics, shows promise; however, adapting these technologies to local environments requires extensive research and development. Armstrong and Pauls (2021) further contend that recent global funding cuts have significantly weakened academic institutions' capacity to develop context-specific solutions, threatening the long-term sustainability of supply chains in vulnerable regions.

2.3 Insecurity and Business Disruption in Fragile States

Contemporary scholarship increasingly focuses on the interface between conflict and economic performance in fragile states, particularly within the framework of supply chain risk theory. The theory posits that disturbances at any point in the product supply chain — such as production, transportation, or distribution — can have knock-on effects throughout the entire supply chain, particularly in low-resilience supply chains. Insecurity in conflict-prone areas, such as the Northern provinces, poses challenges to the continuity of agro-logistics. Empirical research confirms that violent conflicts lead to a dramatic decrease in mobility, an increase in transaction costs, and the destruction of assets. Aigbedion et al. (2019) confirm that insurgency in North-East Nigeria has contracted the agricultural value chain, reducing access to inputs, increasing theft, and raising transportation costs.

Likewise, Sadiq et al. (2024) reveal that armed banditry has disrupted food supply chains in North-West Nigeria, forcing farmers to abandon lands, reducing yields, and inflating food prices. The conflict-economy interface is also evident in other fragile contexts. Guardado and Pennings (2022) argue that harvest-time income shocks in Africa significantly increase militia-led violence in agricultural regions, illustrating the cyclical interaction between economic vulnerability and conflict. Political instability in the Democratic Republic of Congo (DRC) restricts farmers' access to markets, depressing overall rural income and the food supply. Theoretical views, such as Relative Deprivation Theory (Gurr, 1971), as cited by Agunbiade (2024), also suggest that economic inequality and policy failures in fragile states foster disdain and violence, which in turn deepen economic dissatisfaction. This vicious cycle has a dire impact on agro-logistics operations.

2.4 Gaps in Literature

Although literature on agro-logistics, research investment, and conflict in Sub-Saharan Africa has grown over the years, research on how these areas intersect remains limited. Most current studies tend to address these themes separately. For example, studies such as Amare et al. (2025) and Musa, Salami, and Umoru (2022) provide solid empirical evidence on how insecurity affects agricultural productivity. However, they rarely consider the effects on the logistics system or how their findings relate to research funding patterns. The same limitation appears in studies of restrictions on research systems, such as Babu et al. (2017), which do not thoroughly examine the extent to which these limitations contribute to logistical weaknesses during conflict. The cascading impact of insecurity, combined with inadequate funding for the poor research ecosystem, on the smooth operation of agro-logistics enterprises in Nigeria has yet to be fully explored.

Furthermore, although Armstrong and Pauls (2021) also mention the ideological and institutional consequences of funding cuts, they do not ground their analysis in the realities of logistics management in vulnerable regions. Ogwuru et al. (2022) argue about the relationship between insecurity and conducting research in Nigeria, but they do not explain its downstream effects on business resilience and policy adaptation

within the logistics industry. These gaps are especially important given the increasing frequency of donor funding reductions and the worsening security crises in Northern Nigeria. Without a comprehensive understanding of how research constraints and security risks intersect to threaten agro-logistics continuity, policy interventions are likely to stay fragmented and ineffective.

Furthermore, few studies employ a systems-thinking approach that captures the feedback loops between insec-

urity, research capacity, innovation, and logistics resilience. As Stathers, Onumah, and Lamboll (2024) argue, interventions aimed at reducing postharvest loss are often fragmented and poorly coordinated, leading to suboptimal outcomes. This critique also applies to broader agro-logistics systems in fragile states, such as Ni, where policy and practice rarely integrate across research, security, and economic development sectors. Over the years, the literature has also underrepresented the adaptive strategies of logistics enterprises, which often develop mechanisms of survival during crises. In this context, informal strategies are employed, as Bamimore (2024) examines how Bodija Market traders adapt to supply-chain disruptions resulting from the Boko Haram insurgency. It finds that traders rely on diversified sourcing plans, expanded networks, and informal financing arrangements to withstand shocks. However, mainstream academic and policy literature underrepresents these insights, highlighting the need to focus research at the enterprise level. This gap makes the current project both relevant and urgent. It is urgent because it will fill the void outlined above by investigating the intersection of insecurity and insufficient research funding, along with logistics continuity challenges in the Northern Nigerian agro-sector.

3. METHODOLOGY

3.1 Research Design

This study used a descriptive survey research design to examine the dual impact of insecurity and low research funding on sustainable agro-logistics operations in Northern Nigeria. The design was chosen because it captures perceptions, experiences, and institutional practices across sectors involved in agricultural supply chains. It enabled structured collection of quantitative and qualitative data from a geographically dispersed population, making it suitable for collecting standardized responses from many stakeholders.

3.2 Study Area

The study was carried out across four states in Northern Nigeria: Adamawa, Borno, Yobe, and Kaduna. These states represent different agro-ecological and conflict-affected areas, making them ideal for examining the connection between insecurity, research investment, and logistics resilience (Dabo et al., 2024). Adamawa State, located in the North-East, features a mix of mountainous terrain, river valleys (notably the Benue River), and large areas of arable land. It borders Cameroon and is known for both crop farming and livestock production (Silas et al., 2023). Borno State, also in the North-East, has experienced the worst effects of the Boko Haram insurgency, which has disrupted agricultural activities and logistics infrastructure. Despite this, it remains a key area for millet, sorghum, cowpea, and livestock. Yobe State is semi-arid and prone to desertification, but it supports dryland farming and transhumant pastoralism. Kaduna State, located in the North-West, serves as a commercial and research hub. It hosts the most agricultural and scientific institutions in Northern Nigeria, including Ahmadu Bello University. Economically, these states depend heavily on subsistence and commercial agriculture and have large youth populations. However, they also face major challenges like infrastructural gaps, poor road networks, insecurity, and limited research investment, which collectively hinder agro-logistics operations.

3.3 Population of the Study

The study population comprised three primary stakeholder categories. The first group included agro-logistics firms, transport cooperatives, and commodity aggregators operating across the four states. These firms directly handle the movement, warehousing, and distribution of agricultural produce. The second group included research and academic staff from four major universities and research institutions: Ahmadu Bello University (ABU), Zaria; the University of Maiduguri; Federal University Gashua; and Modibbo Adama University,

Yola. The third group consisted of extension officers from Agricultural Development Programs (ADPs) in Adamawa, Borno, Yobe, and Kaduna States. These officers play a vital role in spreading agricultural innovations and working with farmers and logistics actors in rural areas.

3.4 Sampling Approach and Sample Size

A multi-stage stratified sampling method was used to ensure a broad representation of the target population. In

the first stage, researchers intentionally selected four states—Adamawa, Borno, Yobe, and Kaduna—were intentionally chosen based on their agricultural importance and varying levels of insecurity. The second stage involved selecting respondents based on stratification across agro-logistics companies, research organizations, and Agricultural Development Programs (ADPs). The study selected 1,200 respondents: 600 agro-logistics operators; 300 academic and research staff from Ahmadu Bello University, the University of Maiduguri, Federal University Gashua, and Modibbo Adama University; and 200 ADP extension officers across the four states. This sample size was chosen to improve statistical reliability, enable subgroup analysis, and support detailed inferential analysis, especially given the study's focus on security, innovation, and enterprise continuity.

3.5 Data Collection

This study collected data using a structured questionnaire administered across four conflict-affected states in Northern Nigeria: Adamawa, Borno, Yobe, and Kaduna, between February and May 30, 2025. The instrument had two sections: Section A captured demographic characteristics. Section B included 30 structured items measured on a five-point Likert scale, aligned with the study's three objectives. We selected respondents from agro-logistics firms, public research institutions (e.g., ABU Zaria, University of Maiduguri, Federal University Gashua, and Modibbo Adama University Yola), and ADP extension services. Data collection took place from February to May 30, 2025, using the KoboCollect mobile platform. Enumerators were trained locally and deployed in each state under close supervision, ensuring high response validity and completion rates.

To ensure the instrument's psychometric validity, we conducted Exploratory Factor Analysis (EFA) using principal component extraction with varimax rotation. The EFA results confirmed Section B's dimensional integrity, revealing three latent constructs corresponding to the study's conceptual domains. As shown in Table 1, Factor 1 (Insecurity Disruption) accounted for 22.4% of the variance, Factor 2 (Research and Innovation Support) contributed 18.7%, and Factor 3 (Enterprise Continuity Strategies) contributed 15.6%. Collectively, the three factors explained 56.7% of the total variance, indicating strong combined explanatory power. The internal consistency reliability (Cronbach's Alpha) for the three factors ranged from 0.83 to 0.89, confirming the instrument's reliability.

Table 1: Exploratory Factor Analysis (EFA) Results for Section B Items

Factor	No. of Items	Eigenvalue	% of Variance	Cronbach's Alpha
Factor 1: Insecurity Disruption	10	6.72	22.40%	0.89
Factor 2: Research and Innovation Support	10	5.11	18.70%	0.86
Factor 3: Enterprise Continuity Strategies	10	4.57	15.60%	0.83
Total Variance Explained	30 items	–	56.70%	–

3.6 Analytical Techniques

Data analysis used both descriptive and inferential statistical methods. Descriptive statistics, such as frequencies, means, and standard deviations, summarize demographic data and respondents' perceptions across the three constructs. For inferential analysis, we first performed exploratory factor analysis (EFA) to validate the structure of Section B. Then, multiple linear regression analysis was used to examine the effect of

insecurity disruption and research support on logistics continuity strategies. The regression model is specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Where:

Y = Logistics Continuity Score (dependent variable),

X_1 = Insecurity Disruption Score,

X_2 = Research & Innovation Support Score,

X_3 = Years of Experience,

X_4 = Institution Type,

ε = Error term.

3.7 Ethical Considerations

The research strictly followed ethical standards for social science studies. The Research Ethics Committee of Modibbo Adama University, Yola, approved the study. All participants received a research information sheet and an informed consent form explaining the study's goals, their rights, and how their responses would be kept confidential. No personally identifiable information was collected, and all data was stored securely in encrypted formats. Given the risks of working in insecure areas, researchers took special care to ensure their safety and to avoid questions that could be seen as politically or ethnically sensitive.

4. RESULTS AND ANALYSIS

4.1 Demographic Characteristics of the Respondents

The demographic breakdown of the respondents, as shown in Table 2, indicates a balanced distribution across the four study states: Adamawa (24.6%), Borno (25.4%), Yobe (24.2%), and Kaduna (25.8%). Half of the respondents (49.8%) were from agro-logistics firms, while universities and research institutes accounted for 25.2%, and ADP extension services made up 25.0%. The gender distribution was skewed toward males (70.7%), reflecting the male-dominated nature of logistics and extension sectors in Northern Nigeria. In terms of age, most respondents were in the 31-40 years (35.8%) and 41-50 years (31.7%) groups, indicating a largely experienced workforce. Most respondents held at least a bachelor's degree (40.5%) or a master's degree (36.0%), with 14.2% holding a PhD. Among those with a PhD, professional experience varied, with 32.7% having 6–10 years and 32.1% having 2–5 years, suggesting a well-informed and mature sample.

Table 2: Demographic Characteristics of Respondents (N = 1,200)

Variable	Category	Frequency	Percentage (%)
State	Adamawa	295	24.6
	Borno	305	25.4
	Yobe	290	24.2
	Kaduna	310	25.8
Institution Type	Agro-logistics Firms	598	49.8
	Universities/Research Institutes	302	25.2
	ADP Extension Services	300	25
Gender	Male	848	70.7

	Female	352	29.3
Age Group	18–30	210	17.5
	31–40	430	35.8
	41–50	380	31.7
	51+	180	15
Educational Qualification	Diploma	112	9.3
	Bachelor's Degree	486	40.5
	Master's Degree	432	36
	PhD	170	14.2
Years of Experience	Less than 2 years	198	16.5
	2–5 years	385	32.1
	6–10 years	392	32.7
	More than 10 years	225	18.7

Source: Field Survey, 2025

4.2 Effect of insecurity on agro-logistics operations.

Table 3 shows that insecurity significantly disrupts agro-logistics operations in Northern Nigeria. Most respondents strongly agreed that insecurity reduces the movement of goods along supply routes (M = 4.41, SD = 0.67) and causes delays and breakdowns in transportation (M = 4.32, SD = 0.72). Farmers abandoning their lands due to conflict (M = 4.46, SD = 0.55) further highlights how upstream supply chains are directly impacted, leading to serious consequences for logistics flow. Similarly, higher transport costs resulting from security-related risk premiums (M = 4.38) indicate that insecurity not only restricts physical access but also raises operational costs.

Disruptions in regional markets and damage to storage facilities (M = 4.10 and 4.07, respectively) also reveal systemic vulnerabilities. Overall, the average score of 4.23 suggests strong consensus that insecurity remains a major, ongoing barrier to logistics performance in the region. These findings support earlier research showing that violent conflict hampers supply chain continuity both directly, through attacks, and indirectly, by causing unpredictability, delays, and loss of investment.

Table 3: Effect of Insecurity on Agro-logistics Operations

S/N	Statement	Mean	SD	Interpretation
1.	Insecurity reduces the mobility of goods across supply routes.	4.41	0.67	Strong Agreement
2.	Armed conflict causes transportation delays and operational breakdown.	4.32	0.72	Strong Agreement
3.	Many firms suspend operations due to fear of attacks.	4.01	0.83	Agreement
4.	Increased transportation costs due to risk premiums.	4.38	0.62	Strong Agreement
5.	Farmers abandon their farmlands due to insecurity, which affects supply chains.	4.46	0.55	Strong Agreement
6.	Storage and warehousing facilities are damaged in high-risk areas.	4.07	0.78	Agreement
7.	The theft of goods and infrastructure has increased in conflict zones.	4.21	0.74	Agreement
8.	Logistics operations avoid volatile areas, increasing route length.	4.15	0.69	Agreement

9.	Security threats reduce delivery reliability.	4.19	0.71	Agreement
10.	Insecurity disrupts cross-border trading and regional markets.	4.1	0.77	Agreement

Source: Field Survey, 2025

4.3 Impact of declining research and innovation support on logistics resilience

As shown in Table 4, declining research and innovation support is another major constraint on logistics resilience. Respondents strongly agreed that reduced public funding limits capacity for logistics innovation (M = 4.24, SD = 0.65), while insufficient donor support undermines field trials and operational studies (M = 4.10). The lack of localized research and limited collaboration between academia and companies (M = 4.00) contribute to poor dissemination of innovations such as cold chain systems (M = 4.22) and transport modeling (M = 4.01). The underuse of ICT and digital tools (M = 4.05) also indicates institutional delays in adopting global logistics advancements. Inadequate training for logistics personnel and infrastructure gaps worsen these issues, limiting adaptive capacity in high-risk situations. Overall, the mean responses highlight a systemic underinvestment in knowledge systems that could otherwise improve logistics readiness and sustainability. These findings support the idea that resilient logistics depend not only on physical infrastructure but also on continuous research and innovation relevant to the local context.

Table 4: Impact of Declining Research and Innovation Support on Logistics Resilience

S/N	Statement	Mean	SD	Interpretation
1.	Reduced public funding limits logistics innovation.	4.24	0.65	Strong Agreement
2.	Decline in donor support affects field trials and logistics studies.	4.1	0.75	Agreement
3.	Poor infrastructure limits research on transportation and storage.	4.18	0.68	Agreement
4.	Weak collaboration between researchers and firms hinders innovation uptake.	4	0.82	Agreement
5.	Extension agents lack access to new logistics technologies.	4.12	0.73	Agreement
6.	Digital tools and ICT are underutilized due to poor support.	4.05	0.77	Agreement
7.	Research funding cuts weaken logistics personnel training.	4.17	0.7	Agreement
8.	Cold chain development is affected by a lack of technical research support.	4.22	0.64	Strong Agreement
9.	Transport modeling is not widely applied because research dissemination is limited.	4.01	0.79	Agreement
10.	Lack of localized data from field studies reduces policy relevance.	4.28	0.59	Strong Agreement

Source: Field Survey, 2025

4.4 Strategies adopted by enterprises to maintain continuity amid these challenges.

Table 5 highlights various adaptive strategies agro-logistics companies use to address ongoing security and institutional challenges. The most common approach was route diversification to avoid risky areas (M = 4.31, SD = 0.64), followed by community collaboration (M = 4.18), indicating localized risk management methods. The use of real-time digital tools (M = 4.05) and third-party logistics providers (M = 4.10) shows a growing awareness of flexible, technology-enabled options. However, strategies such as relying on informal security networks (M = 3.88) and remote sensing (M = 3.91) received only moderate support, suggesting limited access or weak institutional integration. Notably, respondents recognized the helpful role of extension and research institutions (M = 4.14), emphasizing the importance of hybrid public-private responses. While these strategies show enterprise resilience, their uneven adoption points to differences in capacity, infrastructure, and

institutional backing. The findings reveal that, amid insecurity and declining research investment, many firms are compelled to adopt context-specific, often improvised, strategies to maintain the flow of agricultural goods and services.

Table 5: Strategies Adopted by Enterprises to Maintain Continuity

S/N	*Statement*	*Mean*	*SD*	*Interpretation*
1.	*Firms diversify routes to avoid volatile areas.*	*4.31*	*0.64*	*Strong Agreement*
2.	*Community collaboration enhances safety.*	*4.18*	*0.69*	*Agreement*
3.	*Use of mobile apps and real-time data for route decisions.*	*4.05*	*0.75*	*Agreement*
4.	*Deliveries are broken into shorter, frequent trips to reduce losses.*	*3.97*	*0.81*	*Agreement*
5.	*Informal security networks provide logistical intelligence.*	*3.88*	*0.85*	*Moderate Agreement*
6.	*Third-party logistics providers are often utilized in high-risk areas.*	*4.1*	*0.72*	*Agreement*
7.	*Remote sensing is increasingly applied for monitoring.*	*3.91*	*0.79*	*Moderate Agreement*
8.	*Public-private partnerships help mitigate logistics risks.*	*4.07*	*0.76*	*Agreement*
9.	*Some enterprises use security and climate data for planning.*	*4.02*	*0.78*	*Agreement*
10.	*Extension and research institutions provide technical support to firms.*	*4.14*	*0.71*	*Agreement*

Source: Field Survey, 2025

4.5 Predictors of Logistics Continuity

Table 6 displays the results of a multiple regression analysis examining how selected predictors affect logistics continuity. The model explains 35.6% of the variance (Adjusted $R^2 = 0.352$) and is statistically significant ($F = 164.77$, $p < 0.001$), indicating strong explanatory power. Insecurity disruption had the strongest negative effect ($\beta = -0.334$, $p < 0.001$), confirming its importance as a key factor in logistics instability. Similarly, reduced support for research and innovation was significantly associated with continuity outcomes ($\beta = -0.201$, $p < 0.001$). Conversely, years of experience ($\beta = 0.116$, $p < 0.001$) and belonging to an agro-logistics firm ($\beta = 0.121$, $p = 0.003$) positively influenced resilience, suggesting that institutional connection and operational experience enhance the ability to handle disruptions. These findings highlight that effective continuity planning depends not only on external threats like insecurity and systemic underinvestment but also on institutional embeddedness and human capital within agro-logistics systems.

Table 6: Multiple Linear Regression Results of the Predictors of Logistics Continuity

Predictor Variable	**B**	**Std. Error**	**Beta (β)**	**t**	**p-value**
Constant	2.118	0.207	–	10.233	0.000 **
Insecurity Disruption Score	-0.286	0.043	-0.334	-6.651	0.000 **
Research & Innovation Support Score	-0.193	0.047	-0.201	-4.106	0.000 **
Years of Experience (continuous)	0.064	0.018	0.116	3.556	0.000 **
Institution Type (1 = Agro-logistics firm)	0.241	0.081	0.121	2.975	0.003 **

The regression model summary and diagnostics shown in Table 7 reveal a statistically strong relationship between the predictor variables and logistics continuity. The model produced an R-value of 0.597 and an R^2 of

0.356, indicating that the independent variables explain 35.6% of the variance in logistics continuity. The adjusted R^2 of 0.352 confirms the model's explanatory power after considering the sample size. The F-statistic of 164.77, with a p-value of 0.000, demonstrates that the overall model is highly significant. Additionally, the Durbin-Watson value of 1.91 suggests no autocorrelation among residuals. The mean Variance Inflation Factor (VIF) of 1.33 indicates low multicollinearity, confirming that the predictors independently contribute to explaining logistics continuity.

Table 7: Regression Model Summary and Diagnostics

Statistic	Value
R (Multiple Correlation Coefficient)	0.597
R^2 (Coefficient of Determination)	0.356
Adjusted R^2	0.352
Standard Error of the Estimate	0.422
F-statistics (df = 4, 1195)	164.77
p-value (F-test)	0.000 **
Durbin-Watson	1.91
Mean VIF (Multicollinearity Diagnostic)	1.33

5. DISCUSSION

This study highlights key findings on how insecurity and research funding cuts impact the agro-logistics sector. The finding that insecurity significantly disrupts agro-logistics operations aligns with existing literature. As Abubakar et al. (2022) note, the Boko Haram insurgency and recurring episodes of banditry and rural violence have hindered the movement of agricultural produce across Northern Nigeria, resulting in higher costs, longer delays, and abandoned supply chains. The study's high average scores (ranging from 4.01 to 4.46) support these disruptions, including route closures, reduced delivery reliability, and farmland abandonment. This empirical evidence confirms that insecurity threatens not only physical infrastructure but also internal and consumption linkages in rural areas (Effiong & Owolabi, 2022). It highlights the need for state actors to strengthen security infrastructure along agricultural corridors to prevent disruptions in commodity flow.

Similarly, the study's findings indicate that firms tend to go out of business due to fear of attack and avoid operating even in volatile regions. This finding aligns with Mohammed and Usman (2021), who found that transporters in the Middle Belt and Northeast often avoid key transportation routes, such as the Maiduguri-Damaturu Road, due to violence and robbery. Such operating methods extend routes and increase fuel consumption, thereby driving up logistics costs. Empirical evidence from Bello and Audu (2021) similarly shows that insecurity's cost burden is passed on to consumers through higher market prices. Therefore, this study adds to the growing body of literature that views insecurity as a systemic threat to both micro-level enterprise stability and macro-level food affordability. Stakeholders should invest in risk-sharing mechanisms, such as subsidized transport corridors or regional security collaborations involving local actors.

Additionally, the findings on declining research and innovation support align with empirical evidence showing chronic underfunding of Nigeria's agricultural research and extension system. According to Eze et al. (2020), public research institutions face budget instability, inadequate infrastructure, and limited university-industry collaboration, all of which hinder the development and dissemination of logistics innovation. The high average scores on items related to cold chain issues, lack of ICT tools, and weak research dissemination reflect these systemic limitations. Furthermore, this study's finding that innovation adoption declines with reduced technical research aligns with Olayemi and Babalola (2022), who observed that Nigeria still underuses transport modeling, digital monitoring, and climate-smart logistics because of insufficient technical training and field trials. This situation hampers agro-logistics firms' ability to adapt to volatile environments.

Similarly, the findings also strengthen the link between logistics resilience and institutional factors. Respondents' concerns about weak technical support from universities and extension systems align with Ahmed and Tanko (2021), who noted that the Agricultural Research Council of Nigeria's (ARCN) failure to close research-practice gaps weakens logistics performance. In this study, the lack of localized data and weak researcher–enterprise connections suggest that even when innovations are available, their spread remains limited. These findings highlight the need to improve public research institutions and extension systems, not only for upstream production but also for downstream logistics innovation. For policymakers and research administrators, this means aligning research priorities with current enterprise needs, especially in areas facing ongoing threats to supply continuity.

Similarly, the study's analysis of firms' strategies confirms the existing literature on adaptation to fragile environments. The adoption of diversified routes, third-party logistics, and mobile technologies aligns with Musa et al.'s (2021) findings, who documented similar strategies among onion and tomato traders on the Kano–Kaduna–Lagos axis. Moreover, the moderate uptake of remote sensing and informal security networks aligns with earlier findings that smaller firms lack the capital and digital literacy to fully leverage geospatial tools. However, recognition of public-private partnerships and the role of extension agents as resilience facilitators indicates a positive, albeit underdeveloped, institutional role in crisis adaptation (Verter, 2017). These strategies suggest that formal (technological) and informal (community-based) approaches are combined to maintain supply chains, a finding that should guide development agencies supporting enterprise resilience.

The multiple regression analysis confirms that insecurity and institutional research gaps are key predictors of logistics instability. These results support the theoretical framework that views supply chain risk as influenced by both environmental hazards and institutional capacity. Notably, the positive influence of years of experience and membership in an agro-logistics firm suggests that institutional memory and market exposure can help mediate some risks. This aligns with Umeh et al.'s (2020) framework, which highlights internal capacities within firms as buffers against external shocks. For stakeholders, the message is clear: while external support, such as funding and security policies, is crucial, strengthening logistics firms' internal capacity should also be a priority. This includes training in digital logistics, security risk assessment, and participatory monitoring of transportation networks.

Therefore, the study's findings support and expand upon existing research on the combined threats of insecurity and limited research support in Nigeria's agro-logistics sector. The impact on supply chain continuity is significant, as shown by both descriptive and inferential analyses. However, the resilience strategies identified suggest that, with appropriate policy, institutional, and technological support, firms can continue operating even in challenging environments. The study ultimately calls on stakeholders to renew efforts to enhance security along agro-logistics corridors, strengthen research-extension-firm links, and promote the adoption of scalable technologies. These integrated efforts are essential not only to improve logistics performance but also to advance broader goals, such as food security and rural economic stability in vulnerable regions.

6. POLICY AND PRACTICAL IMPLICATIONS

This study's findings highlight the urgent need for targeted policy measures to address the decline in research funding in the agro-logistics sector. Governments at both the federal and state levels must restore and stabilize budget allocations to public research institutions, especially those involved in logistics and supply chain innovation. Investing in research on cold chain systems, transportation modeling, and ICT-based logistics management is essential to equip enterprises with the tools needed to respond to volatility. The Federal Ministry of Agriculture and Food Security, in collaboration with the Agricultural Research Council of Nigeria (ARCN), should prioritize agro-logistics research as part of its agricultural transformation agenda. International development partners and donor agencies should resume field-level technical support, especially research, through competitive grants and collaborative research platforms involving localities and logistics enterprises.

Given the ongoing insecurity across Northern Nigeria, logistics operations need multiple security measures to protect them. The federal and state governments should develop integrated security plans focused on key agro-

logistics routes, such as Maiduguri–Yola and Kaduna–Kano, through increased Military patrols, community policing, and digital surveillance tools. States sharing critical supply chain routes should formalize regional security cooperation through agricultural security task forces. Furthermore, logistics operators need training in risk-aware route planning, and public-private partnerships should make insurance options for security-related losses available. These steps would help reduce the direct and indirect impacts of insecurity on logistics and rebuild trust among supply chain participants.

Additionally, establishing a program to support private partnerships in innovation is essential for fostering development within a quiet agro-logistics ecosystem. Government agencies should provide financial incentives such as tax rebates, grant matching, and innovation vouchers to companies that work with universities or technologists. Creating regional initiatives with innovative centers, including agro-logistics companies, research labs, and ICT developers, will promote long-term knowledge exchange. At the same time, local institutional capacity needs to increase, especially in agricultural extension services. This includes training extension officers in logistics, advisory roles, and digital tools, enabling them to connect research and practice. The Agricultural Development Programs (ADPs) in Adamawa, Borno, Yobe, and Kaduna should restructure their operations to include logistics planning. The recommended solutions are part of a systems-based framework that leverages security, innovation, research, and institutional capacity to ensure continuity, resilience, and stability of the food system in this fragile environment.

7. CONCLUSION AND RECOMMENDATIONS

This study examined the dual impact of declining research funding on agro-logistics in Northern Nigeria, specifically in Adamawa, Borno, Yobe, and Kaduna States. The findings showed that insecurity significantly disrupts the movement of agricultural products, leading to high operational costs and the suspension or redirection of logistics activities in these areas. Similarly, limited research funding and slow diffusion of innovation hinder the development and adoption of adaptive logistics technologies and strategies. Although firms have developed coping mechanisms such as route diversification, digital tools, and informal networks, these responses remain uneven and largely inadequate given the ongoing insecurity and institutional fragility. The regression analysis confirmed that both insecurity and reduced research support strongly reduce logistics resilience, while institutional ties and professional experience increase it.

The study recommends restoring research funding, such as jointly funded research that addresses the global food supply, to solve hunger—championing the value of multi-sector partnerships with organizations like the Global Agriculture and Food Security Program (GAFSP) and the Canadian International Food Security Research Fund (CIFSRF), which worked directly with academic institutions, civil society organizations, logistics companies, governments, and the private sector to test and deploy proven food security and nutrition solutions—and, secondly, the implementation of multi-level security measures. Additional suggestions include public-private partnerships to foster innovation adoption and capacity building for institutions and extension systems, promoting resilience in Northern Nigeria's agro-logistics.

REFERENCES

1. Agunbiade, O. (2024). Insecurity and Nigeria’s Socio-Economic Development. African Journal of Social Sciences and Humanities Research, 7(2), 166–181.
2. Agwu, A. E., Suvedi, M., Chanza, C., Davis, K., Oywaya-Nkurumwa, A., Mangheni, M. N., & Sasidhar, P. V. K. (2023). Agricultural extension and advisory services in Nigeria, Malawi, South Africa, Uganda, and Kenya. Alliance for African Partnership, Michigan State University.
3. Aigbedion, I. M., Anyanwu, S. O., & Anefu-Apochi, E. E. (2019). The Impact of Insurgency on Agricultural Value Chains in Northeastern Nigeria. Journal of Agricultural Economics, Environment and Social Science, 5(1 & 2), 150–166.
4. Alhassan, Z., & Risikat, M. (2024). Impacts of Regional Leading Sectors on Insecurity in Northern Nigeria: Implications for Sustainable Education. Afropolitan Journals Creative Commons Attribution, 16(1).

5. Amare, M., Abay, K. A., Berhane, G., Andam, K. S., & Adeyanju, D. (2025). Conflicts, crop choice, and agricultural investments: Empirical evidence from Nigeria. Land Use Policy, 148, 107391.
6. Armstrong, N., & Pauls, E. (2021). Funding cuts undermine the global impact of research and its value as an emancipatory project. LSE Impact Blog. https://blogs.lse.ac.uk/impactofsocialsciences/2021/04/01/funding-cuts-undermine-the-global-impact-of-research-and-its-value-as-an-emancipatory-project/
7. Asaleye, A. J., Ojo, A. P., & Olagunju, O. E. (2023). Asymmetric and shock effects of foreign AID on economic growth and employment generation. Research in Globalization, 6, 100123.
8. Babu, S. C., Oyedipe, E. O., Ajakaiye, O., & Ajoni, K. (2017). Strategies for restructuring the Agricultural Research Council of Nigeria: Process, opportunities, and lessons (Working Paper 41). International Food Policy Research Institute.
9. Bamimore, S. (2024). Impact of Boko Haram Insurgency on Bodija Market Traders. (Bachelor of Science project). University of Ibadan.
10. Bradley, M. (2017). Donor funding cuts' impact on global displacement crisis (Internal report, draft). Danish Refugee Council.
11. Dabo, N. A., Nuhu, M., & Bilyaminu, S. (2024). The Effects of Farmer-Herder Conflicts on Food Security in Taraba State, Nigeria. Nigerian Journal of Agriculture and Agricultural Technology (NJAAT), 4(2), 226-237.
12. Dania, C. M., & Oti, E. C. (2022). Insecurity in Nigeria: Implications for economic development as perceived by senior secondary school science teachers. Inter-Disciplinary Journal of Science Education (IJ-SED), 4(1), 89–97.
13. Effiong, M. I., & Owolabi, J. O. (2022). Impact of Conflict on Rural Infrastructures: Implications on Agricultural Development in North Central Nigeria. A Review Study From 2000 – 2020. International Journal of Management, Social Sciences, Peace and Conflict Studies (IJMSSPCS), 5(2), 611–623.
14. Falana, B. J. (2024). The Impact Of Foreign Aid On Economic Growth And Poverty Alleviation In Nigeria. International Journal of Global Economic Light (JGEL), 10(11), 632-652.
15. Guardado, J., & Pennings, S. (2022). Agricultural Windfalls and the Seasonality of Political Violence in Africa. American Journal of Agricultural Economics.
16. Hussain, N. (2016). Impact of Foreign Aid to the Agriculture Sector on Agricultural Productivity in Developing Countries in the context of the Second Goal of SDGs. (Master's thesis). KDI School of Public Policy and Management.
17. Igben, H. G. O., & Etadafe, K. C. (2023). The Challenge of Funding for the Quality of Research in Nigeria. Global Journal of Arts, Humanities and Social Sciences, 11(10), 15–30.
18. Kimenyi, M., Adibe, J., Djiré, M., Jirgi, A. J., Kergna, A., Deressa, T. T., Pugliese, J. E., & Westbury, A. (2014). The impact of conflict and political instability on agricultural investments in Mali and Nigeria (Working Paper 17). Africa Growth Initiative at the Brookings Institution.
19. Musa, M. J., Salami, H., & Umoru, A. F. (2022). Herdsmen Attacks and Agricultural Productivity in Benue and Nasarawa States of Nigeria. Al-Hikmah University Central Journal, 3(1), 13–24.
20. Ogwuru, H. O. R., Okoro, I. O., & Ndubuisi, J. O. (2022). Human Insecurity and Deepening Challenges of Field Research Scholarship in Nigeria. International Journal of Arts and Social Science, 5(11), 42-51.
21. Okolo, D. A. (2006). Agricultural Development and Food Security in Sub-Saharan Africa (SSA): Building a Case for More Public Support: The Case of Nigeria. FAO Subregional Office for East and Southern Africa.
22. Okolo, D. A. (2016). Issues and Challenges in the Transportation Industry in Nigeria and Egypt. The Business and Management Review, 7(2), 605-612
23. Sabo, A., & Abubakar, M. I. (2020). An Analysis of Insecurity Challenges in Northern Nigeria: A Case of Banditry and Insurgency. African Scholar Journal of Humanities and Social Sciences, 18(6), 417-422.
24. Sadiq, M. S., Singh, I. P., & Ahmad, M. M. (2024). The Influence of Armed Banditry on Food Supply Chains in North-West Nigeria: A Comprehensive Review. Kuwait Research Journal of Agriculture and Life Science, 1(1), 1-11.

25. Silas, S. B., Gambo, I., & Hassan, H. I. (2023). Effect of Crop Farmers-Pastoralist Conflict on Crop Output in Adamawa State, Nigeria. Journal of Agricultural Economics, Environment and Social Science, 9(1), 232–248.
26. Stathers, T., Onumah, G., & Lamboll, R. (2024). Postharvest Loss Reduction Interventions in Sub Saharan Africa: Experiences and Perspectives. Natural Resources Institute (NRI), University of Greenwich.
27. Verter, N. (2017). The impact of agricultural foreign aid on agriculture in Nigeria. Bulgarian Journal of Agricultural Science, 23(5), 689–697.
28. Zaria, Y. B., & Ismail, N. A. (2022). Investment infrastructure and development assistance impact on headcount poverty reduction in Nigeria: Autoregressive distributed lag (ARDL) approach. People Centered – The Journal of Development Administration (JDA), 7(1), 17–26.